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JUNIOR CHEMIST.—Initial pay, £E360 plus bonus.

Note.—The Egyptian Government bonus referred to consists of an increase of 20% to salaries and in addition a war gratuity of 60% on the salaries so improved, provided that the increase from the war gratuity does not exceed £E192 per annum and that the total increase from both sources of increment does not exceed £E300 per annum. The Pound Egyptian is worth about sixpence more than the Pound Sterling.

Candidates are expected to be in possession of Honours Degrees in Science, and in the case of the chemical appointments, preference will be given to Fellows or Associates of the Institute of Chemistry.

Applications, together with statements of qualifications and references, which will be received up to July 15, 1920, should be endorsed "Research Staff, Egyptian Ministry of Agriculture," and addressed to SIR ARTHUR WEBB, K.C.M.G., Queen Anne's Chambers, Broadway, Westminster, from whom all particulars regarding conditions of service, etc., can be obtained.

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The Ministry of Agriculture, Egypt, invite applications for the undermentioned appointments on its Agricultural Staff at Cairo. Candidates are expected to be in possession of Honours Degrees in Science.

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THURSDAY, JUNE 24, 1920.

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University and Higher Technical Education.

IN 1881 Mr. Mundella, then Vice-President of the Council, and consequently responsible for the policy of the Board of Education, with full knowledge as a manufacturer of the great growth, since the Franco-German war of 1870, of manufacturing industry in all parts of Germany, and sensible of the increasing unrest in British industry caused thereby, induced the Government of the day to appoint a Royal Commission "to inquire into the instruction of the industrial classes of certain foreign countries in technical and other subjects for the purpose of comparison with that of the corresponding classes in this country, and into the influence of such instruction on manufacturing and other industries at home and abroad." The members of the Commission were chosen from representatives of important industries and others engaged in scientific education. They undertook an extensive and exhaustive inquiry into the conditions and range of the teaching of pure and applied science in the chief European countries and in the United States, and visited also the Universities and colleges and some of the chief schools and workshops of the United Kingdom. After three years' investigation they produced in 1884 an exceedingly full and valuable report, which was widely circulated in this and other countries.

The report laid bare our serious deficiency as compared with the great facilities afforded by foreign Governments, especially those of Germany, Switzerland, and the United States, and it aroused a widespread interest in industrial and educational circles, leading, after a considerable lapse of time, to the passing of the Technical Instruction Acts of 1889 and 1890, which resulted in the establishment of many important technical schools throughout the kingdom.

We have undoubtedly made great progress in science and in its industrial applications during the past generation, but not less marked has been the advance of German industry, which in some spheres of manufacture, notably those of dyes and fine chemicals, in optical glass, and in certain branches of electrical engineering, easily held the first place. The events of the war have demonstrated the resourcefulness of British men of science, inventors, and manufacturers, who to a surprising extent, as shown by the exhibitions held, under the auspices of the British Science Guild, at King's College, London, in 1918, and at the Central Hall, Westminster, in 1919, met the extraordinary demand made upon their knowledge, ingenuity, skill, and adaptability. The time is now again ripe for inquiry as to the means and resources of the kingdom, especially from the point of view of a due supply of adequately educated and equipped men of science to be engaged in industry and commerce, to meet the inevitable industrial and commercial competition which will arise on the resumption of normal conditions and of free intercourse between nation and nation.

The strength of this competition may be illustrated in the instance of a highly specialised product. The balance sheets for 1919 of three of the principal aniline dye companies of Germany are now available. At the nominal rate of exchange, F. Bayer and Co. show a net profit of 1,450,000*l.*, against 654,000*l.* in 1918; Meister, Lucius and Co., 1,210,000*l.*, as compared with 750,000*l.* in 1918; whilst the Berlin Colour Works declare a dividend of 18 per cent., as against 12 per cent. in 1918. On the other hand, the sum available for dividend in the British Dyestuffs Corporation is only 172,505*l.* The report of this company states that there is an unprecedented demand upon it for dyestuffs in both quantity and variety, to meet which requires increased efforts in the direction of production and research. It is recognised that it is of paramount importance to have a department where research work can be carried out along the most modern and scientific lines, and to encourage those engaged on the scientific and research side of the industry.

The production of dyes of high quality in an endless variety of shades, in which the German firms have excelled because of their unlimited command of high-class scientific and technical ability,

the fruit of Germany's technical high schools and universities, is, like some other imported products, essentially a "key" industry, and therefore a dominant factor in the manufacture of finished textiles, which to a very large extent are exported by us to foreign markets, there to meet in competition the goods of other countries. Having regard to the prime necessity of increasing the supply of competent graduates for scientific industrial research, the British Science Guild carefully investigated the subject, and last year issued a report (which has been widely distributed to members of the Government, to the Universities, and to many leaders of industry and commerce) on industrial research and the supply of trained scientific workers. It was shown that in 1914 the number of full-time students of University standard and of students of science and technology in the United Kingdom was relatively small as compared with the number of similar students in the United States and in Germany; and further, that the financial resources of Universities in the British Isles are very much below those of the other countries. Two of the provincial Universities—namely, Manchester and Liverpool—are now engaged in the endeavour to raise the sum of 650,000*l.* and 1,000,000*l.* respectively to enable them to extend their operations so as to meet in some measure the demands made upon them, especially in the departments of science and technology. Leeds and other centres of higher education are also appealing for monetary aid.

There should be, as in 1881–84, a systematic national survey of the conditions now existing and of the requirements necessary to ensure the satisfactory progress of industry and commerce in the United Kingdom. The circumstances arising out of the war have brought about an entire and welcome change of outlook on the part of British manufacturers engaged in the chief industries of the country, evidence of which is to be found in the list issued in April last of nineteen research associations representing various industries which have been approved by the Department of Scientific and Industrial Research, whilst several other industries have submitted, or are engaged in preparing, memoranda and articles of association for approval.

The growing appreciation on the part of the community generally of the advantages of secondary education, together with the requirements of the Education Act of 1918, will of necessity increase the demand for highly qualified teachers, for whose training the Universities and the chief technical institutions will be responsible, necessarily entailing upon them a large additional expenditure. It is, moreover, increasingly recognised that the nation does not take adequate advantage of the best brains in the poorer classes of the community. A broad highway must be established along which they may travel from the elementary school to the University, but this can be accomplished only by the institution of a large number of national maintenance scholarships operating uniformly all over the country, as local scholarships do not, and so providing the means whereby the capable youth may advance from stage to stage from his twelfth year. This would entail a large expenditure, but the nation would be well repaid in the rich harvest it would reap of highly capable men and women.

These considerations lead to the necessity of largely increased State grants in support of University and higher technical education, which should be closely related to the appointment of a consultative committee mainly composed of representatives of industry and commerce and of universities and technical institutions to advise the Board of Education on matters relating to science and technology and their bearing upon the requirements of industry, and also to the division of the country into provinces roughly corresponding to the areas served by the respective Universities, governed by a council composed of existing local authorities, with the addition of members representative of the Universities and of industry and commerce.

If this were done it would be possible to correlate effectively all forms of education, to prevent overlapping, and to equalise the burden of administration and cost, whilst giving equality of opportunity, without distinction of class, to all residing within the province so created. For these reasons the British Science Guild strongly urges the Board of Education to set up a Departmental Committee to make an exhaustive inquiry into the present provision of University and higher technical education throughout the kingdom, with power to suggest how it could best be arranged and developed according to the needs of each area, whether industrial, commercial, or agricultural in character. Such an inquiry could not fail to be fruitful in its results, and would greatly stimulate the interest of all concerned in the conditions making for national well-being in all its aspects.

Mathematics of Elasticity.

A Treatise on the Mathematical Theory of Elasticity. By Prof. A. E. H. Love. Third edition. Pp. xviii+624. (Cambridge: At the University Press, 1920.) Price 37*s.* 6*d.* net.

THIS is the third edition of the classical treatise in the English language upon the theory of elasticity, and all students of the subject will be grateful to Prof. Love for having brought his masterly exposition of this difficult but fascinating branch of mathematical science up to date. The book is now thoroughly well established as part of the education of such mathematicians as have to deal with the engineering or physical applications of elasticity; indeed, it needs some hardihood, even for a specialist, to criticise it; every fresh perusal convinces the careful reader of the inadequacy of his own knowledge.

The changes made in this edition have been slight in appearance, but attention to details will reveal many improvements in both form and matter. The numbering of the sections has not been changed, which is of great help to those students who have learnt to use the second edition. New sections have been interpolated here and there, and these have been distinguished by a letter—*e.g.* 79A.

As previously, a great many references are given to the experimental side of the subject, and very rightly, for in many ways the mathematical theory of elasticity is more closely verified by experience (where verification has been seriously attempted) than the cognate theory of hydrodynamics. Where discrepancies have occurred they can usually be traced either to the inherent difficulty of obtaining an exact mathematical solution of the problem, or to unintelligent experimenting. Far too much experimental work, for example, has been done with systematic disregard of the elastic limits, or without due precautions, in anticipation of 5 per cent. accuracy. For various reasons, the engineer does not find it convenient to *isolate* effects, and he rarely carries out experiments for the express purpose of testing a mathematical theory. Thus what may be called the *physics* of elasticity has advanced comparatively little. The methods of photo-elasticity, first used by Clerk Maxwell, who applied the effect of stress on polarised light (discovered by Brewster) to the investigation of stress-distributions, and recently developed as a working engineering method by Prof. Coker, promise to do much to remove this reproach and to get rid of the difficulty mentioned by Prof. Love that "the components of stress or of strain within a solid body can never, from the nature of the case, be measured directly" (p. 94).

New sections have been added in chap. iv. on the results of Hopkinson and Sears concerning stresses maintained for a very short time, and also on elastic hysteresis. The term "perfect elasticity" to denote that condition in which the stress-strain diagram is closed, although the loading and unloading graphs do not coincide, seems unfortunate, as elasticity can scarcely be called perfect when elastic energy is being dissipated. "Perfect recovery" might denote this case, "perfect elasticity" being reserved for the condition in which loading and unloading graphs coincide. "Linear elasticity" explains itself, but surely the statement on p. 113, given on the authority of Bauschinger, that the limits of linear elasticity are higher than those of perfect recovery, can scarcely be right, since the former condition should imply the latter. An important appendix has been added at the end of chap. ix. on Volterra's theory of dislocations in the case of multiply connected bodies. A simpler proof of Weingarten's theorem that the discontinuities in the displacements on crossing a "barrier" correspond to a rigid body displacement can, however, be given. For if u_0, v_0, w_0 be one value of the displacement at a point P, and u_1, v_1, w_1 the displacement at the same point P after describing an irreducible circuit, u_1-u_0, v_1-v_0, w_1-w_0 are solutions of the equations of elasticity which necessarily (since the strains are supposed one-valued) correspond to zero strain everywhere, and such displacements must be rigid-body displacements. In this connection it would make things clearer for the beginner if in the proof of the uniqueness theorem given in § 118 the limitations as to the nature of the functions and the simply connected quality of the space were stated. Todhunter and Pearson have pointed out that the existence of more than one solution for a multiply connected body is immediately evident to anyone who turns a short piece of indiarubber tubing inside out. The realisation of this fact is apt to shake the student's faith if warning has not been given.

In the chapter on the sphere a very valuable new section gives the alternative method developed by the author in his essay on "Some Problems in Geodynamics," and another section gives a number of new and important references to work on geophysical problems, a branch of elasticity which is assuming nowadays an increasing importance. The work of Lamb and of G. W. Walker in connection with seismology is noticed on p. 314.

§§ 226A and 226B deal with the torsion of a

bar of varying cross-section and with end-effects in torsion.

In the chapter dealing with the elastica, the section (265) which gives the computation of the strain energy of the strut has been practically rewritten and much improved. It might be useful, in dealing with buckling, to dispose of a fallacy common among engineers that Euler's limit implies *failure* of the strut, whereas all that occurs is passage from one type of stable equilibrium to another.

Southwell's method of dealing with problems of elastic stability comes in, naturally, for considerable notice. The buckling of a strut (§ 267A), of a rectangular plate (§ 332), and of a tube (§ 341) are discussed as examples of this theory.

An entirely new chapter (xxiv. A) has been added, dealing very exhaustively with the equilibrium of thin shells in the shape of surfaces of revolution, including in particular a discussion of Meissner's work on the spherical and conical shells.

A feature of this edition (as of the previous ones) is the extraordinarily complete and careful set of references to all the original papers and memoirs dealing with the subject. Needless to say, these references, which have been most thoroughly brought up to date, are invaluable to the reader who takes up the book as a guide to research. The example set by such a master as Prof. Love might well be commended to the younger generation of scientific writers. Too often nowadays, especially in papers dealing with applied science, one comes across a statement of references which betrays the author's ignorance of the literature of his subject, both by the omission of work (sometimes of fundamental importance) done by his predecessors, and by the undue prominence accorded to the minor efforts of contemporaries in his own circle. L. N. G. F.

Behaviourism.

Psychology from the Standpoint of a Behaviorist. By Prof. John B. Watson. (Lippincott's College Texts.) Pp. xiii + 429. (Philadelphia and London: J. B. Lippincott Co., 1919.) Price 10*s.* 6*d.* net.

THERE has been a great deal of controversy, especially in the philosophical journals of America, concerning the theory of behaviourism. Prof. Watson is, we believe, the originator of the term and the recognised leader in its application as a method in psychology. The book before us is not an exposition of the theory; it takes it as accepted, and puts forward an elementary, but nevertheless complete, schematic outline of the science of psychology, its scope and its method, regarded from this point of view. It therefore, better than any detailed exposition, sets before us the advantages and the disadvantages, the limitations and inclusions and exclusions, of psychology as the behaviourist conceives it.

Behaviourism is a theory of the science of psychology based on two postulates. The first is that the only thing the psychologist can study scientifically is behaviour. The second is that there is nothing else in psychology to study but behaviour. When the description of an individual's behaviour is exhausted there is no remainder, no psyche, left out of the account. The first postulate is explicit, the second implicit. It is clear at once, however, that the second is fundamental. Analyse the response of an organised material being to the stimulus of a situation, and you have exhausted psychology. Not only have you gone as far as you can go, but there is also no farther to go.

When you have simplified your science to this extent, the difficulty is to justify it at all. What is the subject-matter of psychology which demands a special method? This is Prof. Watson's difficulty. Physiology is already in the field; it has accomplished a vast amount of this very behaviour study. What is there left over for psychology? What sort of responses are there to which the physiologist can be, and is, completely indifferent, and which fall under the class-heading, psychological? The further we read in this book, the more intensely does this inquiry present itself as the crucial question. Three chapters of the book (no inconsiderable portion of the whole) are acknowledged to be pure physiology, and not psychology, and the reader is told in the preface that he may skip these if he likes, and that if he does so he need be at no disadvantage from his point of view as psychologist. But the physiology is not all so easily excised. When Prof. Watson defines an emotion he has to apologise for the impossibility of avoiding physiological terms. How much, one wonders, would be left of the book if all the physiology were taken out and only pure psychology left? The present writer, at least, as he reads the book finds himself in continual expectation that now he is coming to the end of the physiology and the beginning of the psychology, but is continually disappointed, and the reason is clear enough when Prof. Watson gives at last his definition of the distinction of the two sciences. Whenever, he tells us, we are studying the response of a part of the organism to a

situation we are in physiology; only when we study the response of the whole organism to a situation are we in psychology.

So then it is like this—there are two sciences, let us say, of a motor-car, one in which we study the structure and function of the carburettor, the gear-box, the magneto, etc., and another and different science, in which we study the behaviour of the complete car on the road, its hill-climbing power and its responses to the varying situations consequent on the control of the traffic. No doubt there are people who can drive a car in absolute ignorance of the mechanism they are controlling, and in like manner there may be psychologists with complete knowledge of the responses of the individual, though ignorant of the mechanism of the reflexes on which those responses depend. Neither is to be commended; but can we rest satisfied with such a distinction? Is it not false science to separate the science of the parts from the science of the whole? Can the parts mean anything in abstraction from the whole, or the whole mean anything in abstraction from the parts? This, however, seems to be the behaviourist's idea of the subject-matter and scope and method of psychology and of its relation to physiology.

If your interest is in psychology, surely what you want to study is the subject of experience in its living, conscious, self-active subjectivity. You can, easily enough, regard such subjects of experience as objects, accurately describe their behaviour in varying situations, and formulate fairly useful scientific laws in regard to them, just as you may study the behaviour of a magnet in the neighbourhood of different substances and formulate magnetic laws. But is either scientific? Shall we, in the first case, discover by such a method the nature of imagery, conceptual thinking, apperception, perception of reality and unreality, ideality, rationality, and all the complex products of mental life, any more than in the case of the magnet statistical observations will lead us to discover the electro-magnetic constitution of matter? The essence of behaviourism is to translate the mental into terms of bodily integration and leave it there, satisfied that the work of psychology is now done. There is nothing beyond or different in its nature.

Behaviourism is not condemned by anything positive which it recommends, but by its absurdly extravagant claim that in restricting research to methods of observation and description it is actually making science all-inclusive. This book, for example, indicates numerous most useful experimental methods, and may inspire, and will direct, the student to practical researches of the highest interest to the advance of science. To this extent every psychologist will welcome it. It is difficult to find anything in its principle to disagree with, save only its limitation and negation. It is only when the behaviourist turns to us and says this is all there is—"Thought is the action of language mechanisms"—that we see that from his point of view there is no psychology.

H. WILDON CARR.

The World's Supply of Animal Foodstuffs.

Animal Foodstuffs: Their Production and Consumption, with a Special Reference to the British Empire. A Study in Economic Geography and Agricultural Economics. By Dr. E. W. Shanahan. (Studies in Economics and Political Science.) Pp. viii+331. (London: George Routledge and Sons, Ltd.; New York: E. P. Dutton and Co., 1920.) Price 10*s.* 6*d.* net.

THIS book provides a comprehensive and very interesting survey of the production and consumption of animal foodstuffs, considered especially from the economic point of view. An interesting historical survey is included, which starts with the use made of animal foodstuffs by earlier generations and traces the gradually increasing demand for, and consequent development of, the supplies of these materials. Part i. of the book gives a detailed survey of the production of the various animal foodstuffs in the more important countries of the world.

With regard to animal foodstuffs the author states that the following countries show a definite net surplus when the balance of imports and exports is taken by values, namely, the United States, Russia (with Siberia), Sweden, Denmark, Holland, and Italy. When, further, the net imports or exports of animal feedstuffs are considered in conjunction with those of animal foodstuffs, the following results are observed: The surplus position of the United States, Argentina, Uruguay, Canada, and Russia (with Siberia) becomes intensified, while the deficiency position of Great Britain, Germany, and Belgium becomes, similarly, more marked; at the same time the surplus position of Denmark, Holland, Sweden, and Ireland suffers reduction. The author discusses fully the influence on production of such factors as agricultural machinery, cost of labour, co-operation of farmers, etc. Part ii. deals with the consumption of animal foodstuffs, the rate of consumption, and the economic and other factors influencing that rate.

There has been a rapid increase in the meat-

consuming population of the world during the last fifty years. This increase amounts apparently to more than 90 per cent., and some further allowance should also, in the author's opinion, be made for the rise in the standard of living not only in Europe, but also in Asiatic and tropical countries. One of the chief causes for this increase appears to be the less frequent occurrence of devastating wars as compared with earlier times. Also the opening up of vast new regions of agricultural productiveness encouraged the growth of the meat-consuming population outside Europe, while the development of cheap transport, enabling the surplus foodstuffs and feedstuffs of these new countries to be carried to other regions where local supplies were deficient, had a great effect in making possible the increase of the industrial populations in Europe. From a study of the production and consumption of animal foodstuffs it becomes clear that the supply of these is likely to be considerably less than the demand. The author states that this is due to three causes: Owing to the comparative lack of undeveloped fertile regions, the rate of expansion in the surplus production of pasture-fed meat animals and of concentrated feedstuffs from the new overseas countries is slowing down; the white meat-consuming population has increased; with the general improvements in the financial status of industrial and agricultural workers in Europe, their *per capita* consumption of animal foodstuffs tends to rise.

Part iii. of the book is concerned with the above problems as they affect the British Empire. The study of the Empire's deficiencies, both in animal foodstuffs and feedstuffs, points throughout to its lack of widespread intensive systems of agriculture, for, though land resources are abundant, they remain more or less undeveloped in large areas. The author emphasises the fact that throughout those parts of the Empire inhabited by white people only a relatively small proportion are engaged in agriculture, and they work on the extensive instead of the intensive system. His conclusion is:—

"The Empire, as a whole, requires to have an enormously increased area under cultivation for the production of feedstuffs, not only to make good its deficiency in this direction, but also to provide for the maintenance of food-producing animals and of poultry in much larger numbers than at present, if it is to cover in a more satisfactory way its deficiency in meat, dairy produce, and eggs."

A valuable feature of the book lies in the summaries which occur at the end of nearly every chapter in Part iii., while for Parts i. and ii. the author gives a full summary of the conclusions to be drawn from the general study of the question of food production and consumption.

Life and Lore of Birds.

The Heron of Castle Creek and Other Sketches of Bird Life. By A. W. Rees. With a memoir of the author by J. K. Hudson. Pp. xi+218. (London: John Murray, 1920.) Price 7*s.* 6*d.* net.

A MELANCHOLY interest is attached to this volume, inasmuch as its gifted author selected the articles, which had previously appeared in various serial publications, for re-issue in book form, but did not live to complete their final revision for the press. This task was undertaken by his literary executor and successfully carried through with so satisfactory a result that we are glad to know that sufficient of Mr. Rees's writings still remain to form another of these delightful volumes.

Most of the essays in the series now before us are devoted to bird-life, the various phases of which are graphically described from the personal observations of the author, who did not trust to books for his knowledge, but gleaned his information at first hand from the creatures he loved. The engaging style of writing and the accuracy of the author's notes on the lives and loves of the birds and beasts he watched disarm criticism and form engrossing reading. It is difficult to single out any particular essay as of outstanding interest, but the account of the parent kingfishers teaching their brood to dive for minnows is original, amusing, and instructive, while the observations on the dipper, the efforts of the author to find its nest, and the affection shown by these birds for their mates, entirely captivate the reader. When a cock offered his tribute of a large worm to his lady-love, the author felt, as he watched its antics, that he "could recognise a sentiment subtly different from mere animal passion," and goes on to say:—

"In those rare brief periods of outdoor study when, to my surprise and delight, I have caught a glimpse of what, for want of a better phrase, might be termed the humanity of Nature, I have not merely imagined, but have felt sure, that many of the finest feelings of man—pity, sympathy, devotion, unselfish comradeship—are shared in no small measure by creatures considered to be far beneath our plane of life."

Five essays are given on the life of the partridge at various periods of the year, and these

are so graphically penned that one fancies oneself at the author's side, watching intently the behaviour of these attractive birds, and sharing with them the hopes, fears, and passions incidental to all stages of their brief career in the open, fraught as it is with constant danger from hawk, weasel, fox, or sportsman, and yet alleviated by the intense joys inseparable from the sharing with a mate the important duties of founding a home and rearing a brood of tiny fledglings. The book is not without its humorous side too, as the reader will discover when smiling over the "Misadventures of Bird-watching." While the author is endeavouring to identify a pair of warblers and to find their nest, he is himself closely watched, in the first place, by a puzzled keeper, who suspects him of poaching, and, secondly, by an angry bull in unpleasant proximity, to escape the unwelcome attentions of which the enthusiastic naturalist has perforce to bring into action his fullest powers of strategy.

This well-printed and unusually attractive volume can be recommended to the notice of all lovers of Nature and Nature-lore, and the appearance of a further series of posthumous essays will be very welcome.

Our Bookshelf.

Engineering Descriptive Geometry and Drawing. By Capt. Frank W. Bartlett and Prof. Theodore W. Johnson. Part i. Pp. vii+206. Part ii. Pp. v+207–374. Part iii. Pp. v+375–617+xiv plates. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1919.) Price 27*s.* 6*d.* net.

THIS book gives in full detail the elementary courses of engineering drawing as taught to young midshipmen in the Navy of the United States of America. The instruction is arranged on the assumption that the student is quite without knowledge or experience in the handling of drawing instruments. Part i., occupying about a third of the volume, treats of line drawing in pencil and in ink, lettering, the use and care of instruments and scales; and describes in the minutest detail all the "tricks of the tool's true play" as witnessed in the practice of the draughtsman's art. In these pages the learner has virtually at his elbow, for constant reference, the skilled craftsman and the experienced teacher. His progress should be sure and rapid, even without much help from an instructor.

In part ii. the principles of projection and descriptive geometry are unfolded in close relation to the special needs of engineers.

Part iii. is perhaps the most important section, and the fourteen plates at the end give standard dimensions of such things as bolts, nuts, rivets, pipes, rolled sections, etc., as adopted by the bureaux of the U.S. Navy Department. We have in this part a finely graduated scheme of work in which the student executes finished drawings of machine details from his own dimensioned hand sketches of the actual parts; becomes familiar with the tables of standards; is trained in the reading of drawings, etc. Although the instructions are again minute and full, almost sufficient for self-tuition, there is no suspicion of spoon-feeding, and the student is left more and more to his own resources as he becomes fit. There are chapters on ships' lines and on structural steel and iron work.

The treatment of the subject has been evolved gradually and embodies the results of much experience in class work. It is characterised by thoroughness, and the text-book is a model of what such a book should be. The volume ought to be in the library of every technical school and drawing class in this country. Teachers as well as students could learn much from it.

Intermediate Text-book of Magnetism and Electricity. By R. W. Hutchinson. Pp. viii+620. (London: W. B. Clive; University Tutorial Press, Ltd., 1920.) Price 8*s.* 6*d.*

THE writer of a book such as this is a little handicapped by having to work in accordance with schemes laid down by boards of examiners, and has not quite a free hand in the arrangement and development of his material. Covering the subject up to the "Intermediate" standard, the work is suitable more to the science student than to the future electrical engineer, and in view of the vastness of the field the author has been obliged to cut down the practical parts of the subject in order to provide space for the more academical sections. It is not his fault that the pith ball is made as important as the dynamo. Nevertheless, we would urge that it is as essential for the science student as for the engineer to "think in volts and amperes" before he attempts to grasp subtler refinements, and we should have liked to see Ohm's law and the conception of resistance introduced earlier than p. 304. In the author's treatment of magnetism, on the other hand, with which he commences his volume, he boldly brings his reader face to face with the equation $B=4\pi I+H$ as early as p. 31, adopting "an introductory elementary treatment to acquaint the reader with the general meaning of the terms in use," and giving the fuller treatment in its proper place later. The idea is excellent, and a similar scheme might have been applied to electric currents with advantage.

Taken all round, the work is painstaking and is skilfully compiled. Special attention should be directed to the three concluding chapters on electrical oscillations, passage of electricity through gases, and radio-activity respectively, which form admirable introductions to the portions of the subject founded on the more modern researches in physics.

A Junior Course of Practical Zoology. By the late Prof. A. Milnes Marshall and the late Dr. C. Herbert Hurst. Ninth edition, revised by Prof. F. W. Gamble. Pp. xxxvi+517. (London: John Murray, 1920.) Price 12*s.* net.

THE principal change in the new edition of this admirable and well-established text-book is the substitution of *Dipylidium caninum* for Tænia as an example of a tapeworm. This change has no doubt been determined largely by the common occurrence of Dipylidium and the consequent facility in obtaining sufficient material—especially scolices—for class purposes. The account is illustrated by a page of good figures, but there is an error in the magnification given for Fig. 3. From the point of view of the organs of the segment, Dipylidium—with two sets of reproductive organs in each segment, and the uterus subdivided into capsules in the mature segment—is not so good as Tænia as a type for study by junior students, and for the convenience of those teachers who prefer the latter type a brief description of the organs of the segment of Tænia might be added at the end of the account, together with Figs. 4 and 6 on p. 47 of the previous edition.

In spite of the care with which the book has been edited, a few slips have escaped attention—*e.g.* on p. 12 "Monocystis belongs to . . . the Sporozoa or Gregarines," as if these two terms—one relating to a class, and the other to an order in the class—were synonymous; there is the loose statement on p. 33 that in Obelia some of the buds "have no mouth and become medusæ"; and the amount of acid given in the formula for acid alcohol is incorrect owing to the omission of a decimal point.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Separation of the Isotopes of Chlorine.

MR. CHAPMAN'S conclusion (NATURE, June 17, p. 487) that the isotopes of chlorine should on certain assumptions be capable of separation by chemical means, is clearly wrong, unless there is something not stated in the reasoning to prevent it being applied to the case of a "pure" element, such as, for example, according to the results of Aston, fluorine actually is. Denoting an entirely imaginary difference between two kinds of fluorine atoms by F and F′, the reasoning seems to lead in this case to the obviously absurd result that these two kinds of identical atoms with a purely imaginary difference must be capable of separation by chemical means.

The error appears to be in the equilibrium equation (i)

$$[Cl_2][Cl'_2]=[Cl.Cl']^2.$$

Mr. Chapman does not show how he deduces this, and it is of interest to know whether the error is due to a slip in the application of the theory of chemical equilibria to the case or to a fundamental flaw in that theory. In the present case, if the isotopes are assumed to be chemically identical and the distribution of the two kinds of atoms in the molecules due to pure chance, then if n is the fraction of Cl atoms and $(1-n)$ that of the Cl′ atoms, the fraction of Cl_2 molecules is n^2, of the Cl'_2 molecules $(1-n)^2$, and of the Cl.Cl′ molecules $2n(1-n)$. This gives

$$[Cl_2][Cl'_2]=\tfrac{1}{4}[Cl.Cl']^2,$$

which is in accord with the ratio 9 to 1 to 6, stated by Merton and Hartley for the case $n=0{\cdot}75$ (NATURE, March 25, p. 104), and with Mr. Chapman's own equation (iv) deduced from the assumption that the isotopes are non-separable. FREDERICK SODDY.

A Possible Cause for the Diamagnetism of Bohr's Paramagnetic Hydrogen Atom.

ONE of the difficulties which confronts Bohr's structure of the hydrogen atom is the fact that hydrogen, on his hypothesis, should be paramagnetic, whereas it is, like the majority of the simple gases, diamagnetic. Experiments on the magnetism of gases have, however, always been made above absolute zero, and the atoms must therefore be in motion; and if this motion involves vibrations and rotations of the atom as well as translatory movements, then it is possible for the atom to appear diamagnetic, although it may be inherently paramagnetic. In a paper on "The Mean Magnetic Moment and Mean Energy of a Vibrating Magnet" (Mems. Manchester Lit. and Phil. Soc., vol. lvii., 1913, No. 4) I considered in a simple case how such an effect might arise if a magnet were in a uniform field and free from the influence of neighbouring magnets. In these circumstances, when the vibrations exceed 130° on either side of the position of rest, or if the vibrations pass into rotations, then the magnet will appear to be diamagnetic, because the average time during which the positive and negative poles are in the diamagnetic position is longer than the average time during which they are in the paramagnetic position.

Honda (Phys. Rev., Ser. 2, xiii., 1919) has recently examined at length the effect of all the possible rotational movements of a magnet in his kinetic theory of magnetism, and, with certain assumptions as to the shape of the atom, comes to the same conclusion.

Applying this result to a paramagnetic atom, it is possible that such an atom, in virtue of its motion, may appear to be diamagnetic, and the fact that hydrogen is diamagnetic may be quite consistent with Bohr's paramagnetic model of the atom.

The kind of diamagnetism here considered, which may be called pseudo-diamagnetism, differs from that due to induced electric currents in the atom, which may be regarded as true diamagnetism. Pseudo-diamagnetism will be subject to variation with changes of temperature and with the state of aggregation of the atoms, while true diamagnetism is probably independent of these.

If the diamagnetism of hydrogen should be found to change at a very low temperature and in a very strong field, it would show that the diamagnetism of this gas was probably an effect of the motion of its atoms, and such a result would indirectly help to confirm Bohr's view of the structure of the atom by removing a difficulty. J. R. ASHWORTH.

Rochdale, June 8.

A Stalked Parapineal Vesicle in the Ostrich.

THE ostrich chick on hatching displays an oval, dark-coloured, bare patch towards the hind part of the head. Later, it tends to be hidden by the thick growth of hair-like feathers which cover the head

generally, but even in the adult it can always be recognised by turning the feathers aside. Its position suggests that it is in some way associated with the pineal body, and dissection reveals a large pineal gland directly beneath, though wholly cut off by the skull. Early stages in the developing chick disclose a yet more remarkable formation in the same region, which leaves no doubt that the bare patch is really a brow spot or pineal spot, the ostrich being the only bird in which a permanent structure of this kind has been described.

Ostrich embryos of about twenty-six days' incubation—the full period being forty-two days—display a

FIG. 1.

large pedunculate vesicle projecting from the middle of the bare patch, surrounded by developing feathers (Fig. 1). The stalk is thick, deeply pigmented, and rounded above, but irregular in outline below, while the vesicle is thin-walled and almost transparent, the whole structure strongly suggesting a stalked eye. The outgrowth persists for a few days only, but all ostrich chicks from about twenty to thirty days' incubation reveal one stage or another in its development or retrogression.

Microscopic sections through the fully developed organ reveal the condition represented in Fig. 2. The

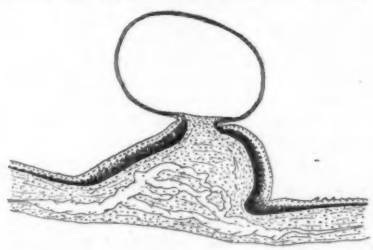

FIG. 2.

stalk is solid and broad below, with a thick epidermis produced into small, irregular fimbriations and deeply pigmented, while the vesicle is extremely thin-walled and filled with a coagulable fluid. The underlying dermal tissue is continued unchanged into the stalk, but below it has undergone a peculiar sclerose modification. The whole structure is thus tegumental and destitute of any special nervous or sensory elements. Beneath it, but not represented in the figure, is the well-developed pineal gland resting upon the pouch-like dorsal sac. Before the vesicle is fully formed, sections reveal that the basal part of the stalk is double, as if two stalks have become fused, but only one has elongated, and ends in the vesicle. At a late stage in retrogression the two components are quite distinct.

A pedunculate vesicle, arising from the middle of the head, renders the ostrich unique among birds as well as among the entire vertebrate series. Its general association, however, leaves no doubt that it is a part of the pineal complex. The latter has, therefore, been investigated from the earliest chick stage, and many significant features have been disclosed. The primary pineal vesicle or epiphysis appears about the third day of incubation as a simple, globular, median outgrowth of the roof of the thalamencephalon; later, it forms a dense follicular system, and communication with the third ventricle is lost. At the time of its formation a small, solid upgrowth takes place just anterior to it, and situated on the right side, afterwards becoming tubular and detached, and extending upwards and forwards over the left cerebral hemisphere. All the evidence points to this as a vestigeal parapineal organ, arising in close association with the pineal organ, but detached from it. It disappears about the tenth day of incubation. A paraphysial upgrowth arises in front of the velum transversum, but persists for a few days only, and a dorsal sac situated immediately under the pineal gland is strongly developed.

It is submitted that the vesicle is the embryonic, persistent, integumental covering of a stalked parietal eye which was present in the ancestors of the ostrich. The sensory part of cerebral origin has degenerated, as in all birds, but the protective corneal covering of transparent epidermis and dermis which would envelop it as it pushed its way upwards still reappears in the embryo, remains for a very brief period, and then retrogresses, the pineal patch being all that persists in later life. The unique stalked character of the eye is manifestly a peculiarity to be correlated with the presence of a covering of feathers in birds.

J. E. DUERDEN.

The Alligator Pear.

THE important notice of *Persea gratissima* in NATURE of May 27 may be usefully supplemented from Madeira, where, during the last sixty years, from ten or a dozen examples, the tree has become familiar in every garden enclosure on the lower 500 ft. of our mountain-sides—cultivated for its attractive form and autumnal yield of valuable fruit.

The revival of the short voyage from Madeira, three days and a half, to Southampton has restored the alligator pear to its former importance in the London market, for no other locality can offer equal facility for presenting this valuable esculent in condition to satisfy the educated palate of those who know the flavour of the fresh fruit.

Grown from seed, *P. gratissima* begins to bear fruit in from seven to ten years, attaining full maturity in twenty years, when it has grown into a spreading tree 30 ft. high or more, with dense light green foliage, maturing an abundant crop in September and October.

A single tree in full bearing will yield a market value of from 8*l.* to 15*l.*, and the rich nutty-flavoured fruit is in growing demand.

In Madeira no serious efforts have been directed to the improvement of the alligator pear, either by selection or grafting, and the large central seed still remains as a reproach to us; but the stimulus of increasing commercial value is at hand, and preference will be given to increased food value. Some years ago I suggested that the tree might be usefully grafted on to *Persea indica*, one of the four Madeiran laurels, much hardier and with greater range, hoping

thus to spread the pear-tree beyond its present limits and to obtain from a more robust stock an increased thickness of edible flesh, and perhaps improvement in flavour; and parcels of *P. indica* seed were sent to the southern United States to test this means of fruit development. But the wild Persea is fast disappearing from our forests through sheer improvidence, and its priceless pink-tinted mahogany will soon be extinct.

The alligator pear—the "midshipman's butter" of other days—is mainly eaten in Madeira as a breakfast-table fruit, generally with pepper and salt, and is especially to be commended as a sapid adjunct to a well-made salad, garnished with segments of the fruit as with hard-boiled egg, and sprinkled with the edible flowers of *Cercis siliquastrum* when available.

The Portuguese authorities will some day realise that the fertile valleys into which these mountain-slopes are cloven may be more profitably occupied than with sugar-cane by the custard apple, alligator pear, and other plants the perishable product of which Madeira only, from its situation, can supply in perfection to the European markets; and our perennial green peas, Cape gooseberries, February strawberries, hognuts, and broad beans will then be available in profusion while the Northern markets still wear their wintry aspect. MICHAEL GRABHAM.

Madeira, June 7.

Eye-Colour in Bees.

EVERY biologist is now familiar with the colour-variation in the eyes of Drosophila, and the remarkable contributions to biological theory which this variation has made possible. It is not so well known that among the Anthophorid bees there are striking differences in eye-colour, which must have arisen in a manner analogous to those of Drosophila. These differences usually characterise species; thus in the genus Centris one form has the eyes crimson, another green, another grey. In Anthophora two closely related species from New Mexico differ, one having the eyes green, while in the other they are dark purplish. There are other differences, and the species are quite distinct. I have just obtained evidence of mutation in eye-colour within the species. *Anthophora porterae*, Ckll., is a large species with clear green (olive-green or pea-green) eyes. The varieties *Watsoni* and *semiflava* agree with the typical form of the species in this respect. However, on May 23 of this year, at White Rocks, near Boulder, Colorado, Miss Marie Chandler found a male with the eyes dark bluish-green (sea-green). This may be called mut. Thalassina. On drying, after death, the eyes became grey marbled with black.

T. D. A. COCKERELL.

University of Colorado, Boulder.

British and Foreign Scientific Apparatus.

IT may be said at once with emphasis that British scientific instruments cannot be made in factories at the present wage-rates and under prevailing labour conditions at twice the pre-war prices if identical in quality and construction. Mr. Ogilvy discloses the same fact with regard to German instruments when he states in NATURE of June 3 that the wages rates of Germany are 400 per cent. higher than in 1914, and that working conditions are difficult in every way.

The only reason that German firms can sell in English money at from 60 per cent. to 100 per cent. above pre-war rates is on account of the benefit they have under to-day's rate of exchange, which values the mark at 1½*d.* only. It is obvious that German firms are doing remarkably well for themselves by selling in England at about twice the pre-war price.

The question is not one of free trade, prohibition, or import under licence, but whether the scientific instrument manufacturing of this country is to continue or not. It is recognised that scientific apparatus is a necessity to the nation, and should properly be maintained as a "key industry." The manufacturers have the courage and the enterprise, and have been making preparations for production by new methods on a large scale for many months under exceedingly difficult conditions, but with the assurance that some degree of protection would be given to them.

I have before me as I write an offer of 11,935 prism binoculars lying in London by leading German makers, all at the same price and far below the cost at which similar binoculars can be made in this country at the present time. This, surely, is a case of "dumping."

It must never be forgotten that the scientific instrument makers in this country were among the foremost in the production of precise instruments for the war. Works were enlarged and plant increased to make instruments of which the Government had never encouraged the manufacture in this country, preferring to buy from Germany in times of peace; and the more effectually a comparatively small firm did its work in war-time, the more it is handicapped now. Several firms are laden with premises and plant, and have excess profits liabilities which are difficult to meet in cash, while capitalists will not put money into scientific instrument manufacturing businesses under present conditions.

Production would be hastened on a scale commensurate with the needs not only of this country, but also of the world, if these facts were faced and met; and it is the opinion of scientific instrument makers that some degree of protection should be afforded during the period that the mark and the franc have such a depreciated value.

There are no "trusts" in the British optical world, as a correspondent in NATURE suggests; there is severe competition between all manufacturers.

British manufacturers have never been slow in throwing open their works for the inspection of those who are interested, and if your correspondents and readers could be induced to pay a visit to some of the works in this country and see exactly what is going on and the possibilities that exist, they might be led to take a view of the subject which would offer encouragement to the hardly pressed, but still optimistic, British scientific instrument maker.

If any readers of NATURE should wish to visit optical works, and would send a note to the secretary of the British Optical Instrument Manufacturers' Association, Ltd., 2–3 Duke Street, St. James's, arrangements would quickly be made.

F. W. WATSON BAKER.
(W. Watson and Sons, Ltd.)

313 High Holborn, London, W.C.

Applied Science and Industrial Research.

PROF. SODDY and Major A. G. Church both say in NATURE of June 3 that my letter published on May 27 confuses the issue. It may be so: I have never known a controversy in which each side did not, sincerely, accuse the other of the sins of irrelevancy and confusion. I have no desire to enter on a detailed discussion of personal views. My sole aim was to raise certain principles that seemed to me in danger of being overlooked. I think Prof. Soddy's suggestion will meet the case: that readers of NATURE who are interested should obtain a copy of the full report of his address. They can then judge for themselves how much or how little occasion there was to justify my letter. J. W. WILLIAMSON.

3 Canterbury Mansions, N.W.6, June 12.

Wireless Telephony.

By PROF. W. H. ECCLES.

WIRELESS telephony has made such rapid progress during the past six or seven years that it must now be looked upon as a possible rival to wireless telegraphy for communication over distances up to a thousand miles. Although telephonic communication demands on normal occasions the expenditure of more power than does communication by Morse signs, yet the superior rapidity with which thought can be conveyed by voice transmission is a weighty advantage; and, besides, telephony often proves more successful than telegraphy when strays and analogous disturbances are bad, partly because the ear is so skilful in following the voice in the midst of other noises, and partly because the context greatly assists comprehension. Many of the recent improvements by which the present position in wireless telephony has been reached are due to the development of the thermionic vacuum valve with three electrodes—called, for short, the triode.

The essential difference between wireless telephony and wireless telegraphy is that the voice is used instead of the Morse key to produce alterations in the radiated electric waves. In continuous-wave wireless telegraphy the Morse key, and in wireless telephony the voice, may be applied in two ways: (1) for altering the wave-length, and (2) for altering the amplitude, of the oscillations in the antenna. A distant receiving station capable of sharp response to the normal wave-length of the sending station picks up less energy from the altered waves passing over it, whichever type of alteration is in use at the sending end; for if the amplitude at the sender is altered, the amplitude of the electric and magnetic fields produced at the receiver is changed correspondingly, while if the wave-length at the sender is altered, the receiving station responds less, because the incoming waves are out of tune with it. In many telegraph and telephone systems both types of alteration occur together.

Once the source of continuous waves is available, the main problem in wireless telephony is to provide means of exciting the transmitting antenna in accordance with acoustic vibrations produced by the voice. The process of moulding the oscillatory currents by means of the voice has come to be called "modulation," and the apparatus used, if distinct from the rest of the transmitting apparatus, is called the "modulator."

The obvious method of modulating a given high-frequency alternating current is to use the familiar apparatus of ordinary line telephony. In our ordinary line telephone services direct current is passed through a carbon microphone, and is constant in value so long as the granules in the microphone are quiescent, but when the granules are made to vibrate by the voice, the current is correspondingly modulated, and may be made to produce sound by the familiar telephone receiver consisting of an electromagnet and an iron diaphragm or reed. In wireless telephony the microphone may be used in a precisely analogous way by being placed in the antenna as shown in Fig. 1, or in an earlier circuit as shown in Fig. 2. In the apparatus of these diagrams the oscillatory current may come from an arc, an alternator, or a triode.

A different method of modulating a given source of supply was advocated, especially by R. A. Fessenden in America, early in the history of wireless telephony. The essence of this method was the employment of a condenser of which one surface could be moved relatively to the other by the voice, and this was usually associated with the antenna of the sender. Alterations of the electrical capacity of the condenser produce departures from resonance, and therefore alter the amplitude excited in the antenna by the source of oscillations. On the other hand, the condenser may be used in the circuit generating the oscillations, especially when the source is an arc or a triode, and in this case the frequency of the oscillations supplied to the antenna is modulated by the voice, and consequently both amplitude and frequency of the oscillations in the antenna are modulated. The condenser has to be of special construction in order that its capacity shall be variable at a frequency of 1000 per second. In the recorded experiments it has consisted of a thin diaphragm placed very close to a fixed parallel plate, and the diaphragm has been acted upon either directly by the voice or indirectly by means of some magnified microphone currents passing through an electromagnet.

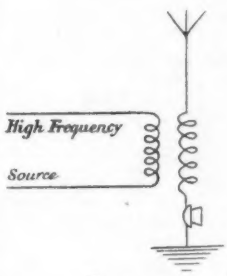

FIG. 1.

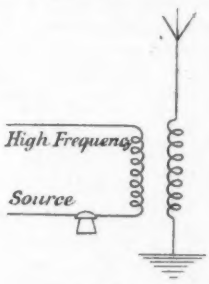

FIG. 2.

The above two methods accomplish modulation by variation of the resistance and of the capacity respectively of one or other of the oscillatory circuits. It is natural to consider the possibility of varying the remaining electrical magnitude—namely, the inductance, self or mutual. The variation of self-inductance has been employed by both German and American experimenters, but perhaps the most successful is that due to E. F. W. Alexanderson, of the General Electric Co. of America. In a broad sense this experimenter takes advantage of the dependence of the permeability of iron upon the intensity of the magnetic

field applied to it. Upon the same core of finely laminated iron there is a winding to carry high-frequency current and one for the microphone current. The microphone current as it varies takes the iron to different magnetic states, alters the permeability accordingly, and therefore varies the self-inductance of the high-frequency coils. Many matters of detail have had to be worked out in perfecting the apparatus; an important one

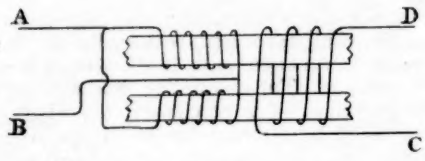

FIG. 3.

may be explained by aid of Fig. 3. Here A, B are the terminals of the high-frequency circuit, and C, D those of the direct-current or microphone circuit. The iron core seen in the figure is part of a closed magnetic circuit; it is in two portions, each of which carries half of the high-frequency winding; the microphone winding encircles both portions of the core. Since the high-frequency windings are wound to exert opposite magnetomotive forces on the halves of the core, they induce negligible high-frequency electromotive forces in the microphone coil.

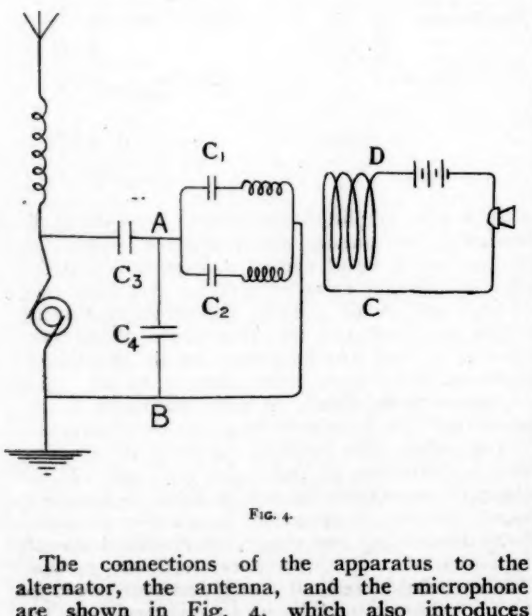

FIG. 4.

The connections of the apparatus to the alternator, the antenna, and the microphone are shown in Fig. 4, which also introduces further details, namely, the four condensers. For simplicity the windings are represented without their cores, though it must be remembered that the operation of the device depends entirely upon the magnetic properties of iron. The condensers C_1 and C_2 have as their chief function the prevention of the flow of undesired acoustic currents in the high-frequency windings. The condenser C_3 tends to annul some of the non-varying inductance in the circuit comprising the magnetic controller and the alternator, and the condenser C_4 appears to have been introduced for phase adjustment, and enhances the sensitiveness of the whole arrangement to changes of microphone current. The performance of the device is excellent; it is stated that a variation of 0·2 ampere in the direct current through the microphone has been made to alter the power given to the antenna from about 6 kw. to 43 kw.

It was by aid of this device that Ministers in Washington conversed with President Wilson in mid-Atlantic, the voice currents reaching the magnetic controller after passing over land wires from Washington to the New Brunswick wireless station. It will be noticed that in this method of varying an element of the complete antenna circuit the variation is not effected directly by the voice, and in this respect the method is unlike the former two methods.

A related class of methods of modulating the oscillations of the antenna is that in which a voice-varied mutual inductance is employed to transfer the high-frequency energy from the source to the antenna. Perhaps the nearest approach to such a method is that of Kühn, of the Telefunken Co. of Germany, though in his method the self-inductance of the circuits is varied also. The method has not worked out so successfully as that of Alexanderson, and need not be described here.

A third class of methods of modulation aims at varying the activity of the source of high-frequency current; this is in contrast with the preceding methods, in which the functioning of the source is not directly controlled. In the methods to be described the point of application of the control is, so to speak, behind the source, the antenna being supposed to be in front. For example, the direct current that creates the magnetic field of a high-frequency alternator, or the direct current or voltage supplied to one of the circuits of a triode oscillator—that is, an oscillatory circuit sustained in oscillation by means of a three-electrode vacuum valve—might be varied by the voice, and the high-frequency output to the antenna be varied accordingly. Many very miscellaneous schemes have been described; the difficulty is to make a representative selection. The triode oscillator especially lends itself to a multitude of ingenious designs.

In Fig. 5 the circuits of a simple form of oscillator are sketched. The coil marked L is connected at one end to the anode, at the other to the grid, of a triode, the filament being connected to a tapping in the coil. The inductance L of the coil and the electrical capacity C of the condenser constitute the circuit in which oscillations are to be maintained. The action of the circuits may be explained broadly thus: Suppose an oscillatory

current to be flowing in L and C, and that we choose an instant when the grid is, say, at a positive potential relative to the filament and rising in value; in accordance with the properties of these tubes the electromotive force transferred from the grid to the anode circuit of the tube will be from filament to anode outside the tube and rising in value. Thus the electromotive force acting on the portion of the coil in the anode circuit is in phase with the potential difference postulated to exist throughout the coil in virtue of the oscillating current in it, and therefore the electrical motion tends to be maintained.

In such an oscillator the frequency of the oscillations is mainly determined by the inductance and capacity, but every other circumstance of the circuits has its influence. Moreover, the amplitude of the oscillations often varies when the frequency does. Thus if acoustic variations be imposed upon the current employed for heating the filament, or upon the electromotive force in the anode circuit, or upon a source of electromotive force between grid and filament, the high-frequency output of the assemblage varies correspondingly. An ordinary microphone will, it need scarcely be said, be used for converting the voice-made air vibrations into current variations, and transformers will be used when of advantage for introducing the current variations into the various circuits mentioned above.

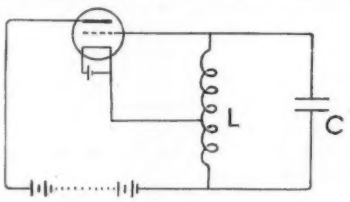

FIG. 5.

One of the most interesting of these methods was described by Major Prince in a paper read recently before the Wireless Section of the Institution of Electrical Engineers, the apparatus being that finally adopted by the R.A.F. for aeroplane work.

The principles employed may be seen from Fig. 6, which is drawn as free from detail as possible. The antenna A is maintained in oscillation by the transmitting triode R_1 in a manner similar to that of Fig. 5; the modulator tube R_2 magnifies the voltages applied to its grid by the microphone currents in the primary of the transformer T. The high voltage for the anode circuits of each tube is supplied by the battery E, which is in series with a large choking coil χ. When the microphone is quiescent the full voltage of E acts steadily on the anode of R_1, but when the microphone produces variable electromotive forces on the grid of R_2 these are multiplied, transferred to the anode circuit of R_2, and if the choking coil is large enough to be effective, and the condenser C not too large, they reach the anode circuit of R_1. In consequence the amplitude of the oscillations generated by R_1 is varied in correspondence with the microphone current variations, and to a small extent the frequency is changed also. This set of apparatus is styled a 20-watt set.

When the normal range of transmission must attain 100 miles, the problem of modulating the necessary power becomes formidable, chiefly on account of the limitations affecting the microphone. It is obvious that direct modulation by means of ordinary microphones is impossible except for small currents, say not exceeding 2 amperes; in consequence, in the endeavour to achieve long-range telephony, special microphones —some of them employing liquid conductors— have been devised, and sometimes many microphones have been used in parallel. At this stage the three-electrode vacuum valve comes to our assistance in various ways, some of which must now be explained. In the first place the triode may be employed as an amplifier of the variable currents or electromotive forces leaving the microphone, and these may be applied to the

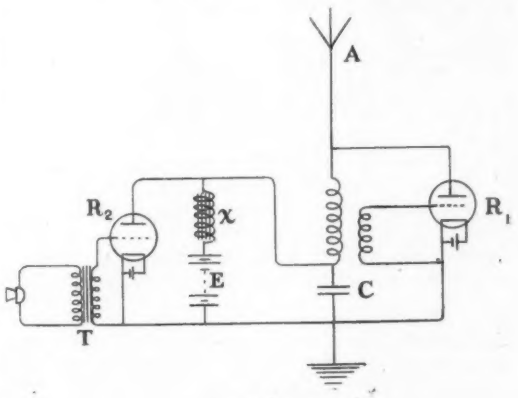

FIG. 6.

modulation of larger high-frequency currents than was before possible; the tube is then the actual modulator. An instance of this appears in Fig. 6. In the second place the triode may be utilised as a by-pass to deflect high-frequency current from the antenna to itself or to other apparatus capable of dissipating the necessary amount of energy—a subtraction method that has proved very successful. The tube may serve in either or both of these functions as modulator of the high-frequency current from arcs, alternators, or other sources of oscillations, not omitting the triode oscillator itself. Evidently the fact that these three-electrode valves can perform the distinct offices of generator of oscillations, magnifier of high and low frequencies, and modulator, and in each office may be associated with a remarkable variety of circuits, may be expected to lead, and is leading, to endless permutations and combinations in the circuits proposed for medium- and long-range wireless telephony.

There is space for brief descriptions of only two examples of large power plants. In 1914

the Western Electric Co. conducted a great experiment from the American naval station at Arlington, near Washington, and succeeded in speaking to the Eiffel Tower (3700 km.), and exceptionally to Honolulu (8000 km.). Triodes were used as oscillators, modulators, and magnifiers. The chain of apparatus was as follows: First came a triode oscillator of small power, which was coupled by means of a high-frequency transformer to the grid circuit of a medium-sized tube. This grid circuit contained also the secondary winding of a transformer, the primary of which carried the currents from the microphone. The anode circuit of this medium triode therefore contained magnified modulated current of the high frequency dictated by the small triode oscillator. The current was next transferred by means of a transformer from this anode circuit to the grid circuit of a bank of medium-sized amplifying tubes connected in parallel, and was again magnified, and finally it was transformed once more into a circuit containing the grids of more than 500 parallel connected tubes. It ought to be remarked that great progress has been made since 1914 in the manufacture of power bulbs, and that the experiment can now be carried out on a larger power scale with a far smaller array of tubes.

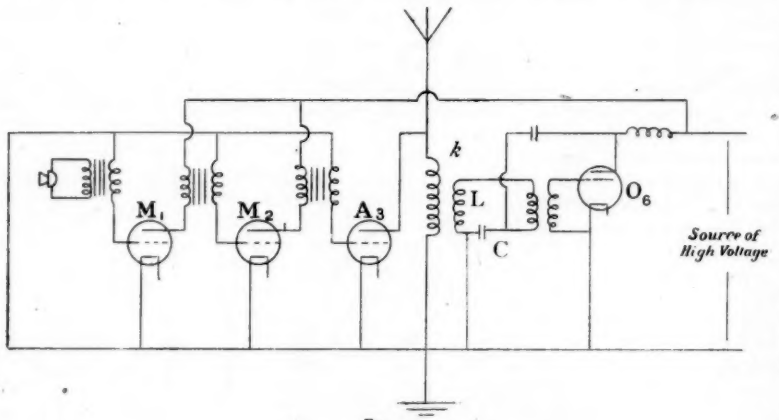

FIG. 7.

The remaining example to be cited is the recently erected 20-kw. plant of the Marconi Co. During the past few weeks it has transmitted good quality speech to a distance of 1500 miles. In principle it is of the subtraction or absorption type. A diagram of the chief parts appears in Fig. 7, from which are omitted all details regarding the heating currents for the filaments and concerning the rectifying of the high-voltage current for the anode circuits. The oscillations are generated in the circuit L C by a bank of six large three-electrode valves in parallel marked O_6, and transferred to the antenna by the coupling k. The absorption tubes are three in number, and are shown at A_3; their three anodes are large enough to dissipate all the energy normally given to the antenna. These absorption triodes are controlled by applying to their grids the speech electromotive forces after these have been magnified by the successive triodes M_1 and M_2. The total consumption of power is 20 kw., including all that necessary for heating the filaments, the height of the aerial is 400 ft., and the wave-length 2750 metres.

It will be noticed that the above are all one-way methods—that is to say, the two persons using two stations for conversation must speak in turn, and the listener must wait for the speaker to finish before he switches over from his listening circuit to his speaking circuit. This falls far short of perfection. For perfect telephony it is essential that both persons shall be able to speak and hear simultaneously if they so desire, as in ordinary line telephony. For information about the most modern attempts at duplex telephony a paper read recently before the Institution of Electrical Engineers by Mr. P. P. Eckersley should be consulted. Until a complete duplex method is devised and proved, wireless telephony must remain a somewhat irksome mode of communication for public use. The ideal method will be such that a wireless station on this side of the Atlantic could be connected over land lines to, say, London, and a station on the other side connected by land lines to New York, and the persons using the apparatus would be unable to tell that wireless telephony across the ocean had been an agency in the transmission of their voices.

The Meteorology of the Temperate Zone and the General Atmospheric Circulation.

By PROF. V. BJERKNES.

IN Norway, since the year 1918, an attempt has been made to base forecasts of weather on the application of a very close network of meteorological stations. The study of the corresponding very detailed synoptic charts has led to interesting results even for large-scale meteorology. These are due especially to three young meteorologists, J. Bjerknes, H. Solberg, and T. Bergeron, who have been attached to this service, and will return to the subject in detailed papers.

A very short summary of some of the main

results will be given here. These will be seen to give, to some extent, both verifications and further developments of ideas, which, although advanced by leading theoretical meteorologists, have not yet exerted any noticeable influence upon the development of meteorology.[1]

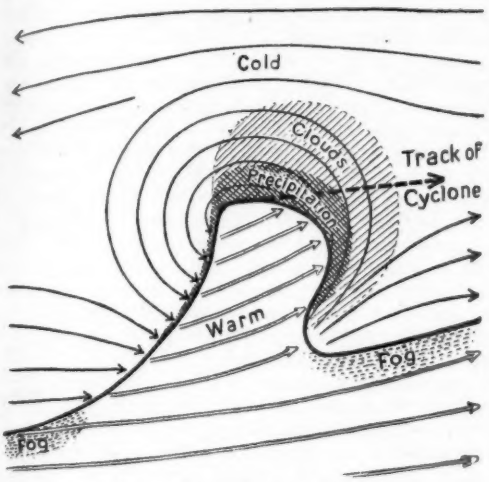

FIG. 1.—Cyclone.

Great changes in the weather in our latitudes have been found to depend upon the passage of a line of discontinuity which marks the frontier between masses of air of different origin. A line of this kind was first found to exist in every current of cold air (Fig. 1). The whole system moves with the east-bound current, and the cyclonic centre with the lowest pressure is in the region where the cyclonic track touches the border of the tongue. The front border, before this point, is curved like a reversed "S"; the rear border, behind this point, has a uniform concave curvature. Along the front border warm air from the tongue ascends the barrier formed by the cold air, which, in return, passes round the tongue in order to penetrate below the warm air along the rear border. Two bands of rain are thus formed —a broad one in front of the tongue, where the warm air spontaneously surmounts the cold, and a narrow one, generally called the squall line, along the rear border, where the advancing cold air violently lifts the warm air of the tongue.[2]

It has been found by use of the detailed maps that the line of discontinuity exists even outside the cyclone, passing from one cyclone to the other; they follow each other along a common line of discontinuity, like pearls on a string.

When one has become acquainted with all the signs—direct and indirect—which are seen to indicate the position of a line of discontinuity on the very detailed maps, it proves possible to discover them even on less detailed maps. Fig. 2 shows roughly the course of such a line, on January 1, 1907, as it may be drawn upon the Hoffmeyer maps of the Atlantic Ocean for that day. When similar charts are drawn from day to day, as accurately as circumstances allow, a series of large-scale results very distinctly presents itself.

Though we have been able to draw the line only half round the pole, there can be no doubt that

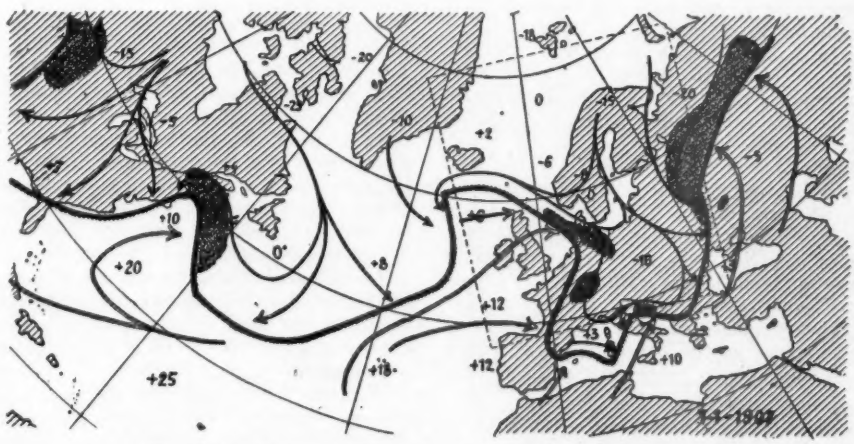

FIG. 2.—Line of demarcation between polar and equatorial air, January 1, 1907.

cyclone which is not perfectly stationary. It here borders a tongue of warm air, which from an east-bound current penetrates into a west-bound it surrounds the polar regions as a closed circuit. On the northern side of this line all signs indicate air of polar origin; it has a low temperature for the latitude, shows great dryness, distinguishes itself by great visibility, and has a prevailing

[1] Dove: "Das Gesetz der Stürme," Vierte Auflage (Berlin, 1873). Helmholtz: "Ueber atmosphärische Bewegungen," Sitzungsberichte der K. Preuss. Akad. der Wissenschaften 1888, *Meteorologische Zeitschrift*, 1888. Billouin: "Vents Contigus et Nuages," *Annales du Bureau Central Météorologique*, 1898. Margules: "Energie der Stürme," Jahrbuch der K. K. Centralanstalt für Meteorologie, 1903, Anhang.

[2] Cf. W. N. Shaw: "Forecasting Weather," p. 212 (London, 1911). J. Bjerknes: "On the Structure of Moving Cyclones," Geofysiske Publikationer (Kristiania, 1919).

motion from east and north. On the southern side of the line the tropical origin of the air is recognised by the corresponding signs—its generally higher temperature, its greater humidity, its haziness, and its prevailing motion from west and south. There can then be no doubt concerning the origin of the line. Heavy, cold air flows out along the ground from the polar regions. It is separated from the overlying warmer air by a surface of discontinuity, the height of which above the ground decreases very slowly until it cuts the ground along our line of discontinuity. Thus this line shows how far the cold air has succeeded in penetrating; it is a kind of *polar front line*.

Along the whole of this front line we have the conditions, especially the contrasts, from which atmospheric events originate—the strongest winds, the most violent shifts of wind, and the greatest contrasts in temperature and humidity. Along the whole of the line formation of fog, clouds and precipitation is going on, fog prevailing where the line is stationary, clouds and precipitation where it is moving.

The line has a wavy form, and is in a continuous undulating motion, thereby sweeping over the whole of what is called the temperate zone. The wavy form comes from alternately cold and warm tongues of air, which extend themselves towards the equator or the pole. The whole system is moving from west to east, while the line, at the same time, changes its form, especially when great masses of accumulated cold air are expelled from the central polar regions. The more wavy the form of the line, the more tempestuous and variable is the weather. At the northern ends of the warm tongues the air motion which characterises cyclones is recognised, and the corresponding areas of rain are seen so far as it has been possible to mark them from the few observations; these are the places of great storms and low barometric pressure. The broad tongues of polar air, on the other hand, bring the clearing up between the successive storms and the corresponding higher barometric pressure.

Two expanding tongues of cold air may occasionally cut off from its base an interjacent tongue of warm air. Then the storm at the polar end is no longer supplied by warm air, and soon loses its power; this is the death of a cyclone. A tongue of polar air which has extended itself too much towards the tropics may be cut off in a similar way; or, as the consequence of a new outbreak of polar air, a more retired front may be formed behind one too far advanced. In this way great isolated isles of polar air are formed in lower latitudes; this gives the formation of great anticyclones, which generally bring settled, good weather. Thus anticyclones are born as cyclones die. Cyclone and anticyclone and all meteorological events of the temperate zone are in the most intimate way related to the polar front and its motion.

This expulsion of great masses of polar air, which leads to the formation of anticyclones, also enters as an essential element into the great atmospheric circulation. There is a practically continuous flow of warm air along the ground from the "highs" of the sub-tropic calms towards the polar regions. This flow concentrates itself in the warm tongues, and continues into the polar regions in upper levels. Here the air is cooled, and eventually reaches lower levels. Thus increasing masses of cooled air are accumulated behind the polar front. This must continuously advance, with the effect that the tracks of the corresponding cyclones are always moved further towards the south. Finally, at the place of least resistance, great masses of cold air break through and are expelled in the direction of the tropics. The polar front performs a corresponding retreat, the cyclonic tracks are again displaced to the north, and the type of weather is changed. Then the same action repeats itself. This intermittent form of the great atmospheric circulation is especially pronounced in the winter. During the summer the polar front is far back, and the high temperature of the continents exerts a considerable influence; then occasionally a continuous return of polar air may be established along the west coast of the continents, leading direct into the trade winds.

These results cannot fail to exert a considerable influence upon the methods of weather forecasting. All meteorological events of the temperate zone, great and small, are derived from the general atmospheric circulation described above, as we know it from the motions of the polar front. If we succeed in watching it effectively it should be possible not only to give short-range forecasts a hitherto unattained accuracy, but also to complete them by long-range forecasts giving the general character of the weather perhaps for weeks ahead. These two kinds of forecast could be extended to all regions of the temperate zone—oceanic as well as continental. The required survey of the polar front is merely a question of organisation.

The Cardiff Meeting of the British Association.

PREPARATIONS are going steadily forward in Cardiff for the forthcoming meeting of the British Association from Tuesday, August 24, to Saturday, August 28 inclusive. Owing to the crowded state of the town, the question of accommodation is causing difficulties, but these will, it is expected, be satisfactorily overcome. A list of hotels and lodgings will be issued at the end of the present week.

The Marquis of Bute has generously offered to give a garden party at the Castle on the Wednesday afternoon, and the invitation has been gratefully accepted by the Lord Mayor on behalf of the local executive committee. Owing to the

difficulties of transport, it has been necessary to give up the proposed reception by Lord Treowen on that afternoon, but it is hoped that arrangements can be made for a visit to be paid to Llanover in connection with one or more of the Saturday excursions.

A long list of works, factories, and other industrial undertakings has been compiled, some of which are sure to be of interest to the various members of the association.

Exhibitions will be a great feature of the meeting. The National Museum of Wales is arranging to display some of its treasures. There will be an exhibition of pictures and charts for school decoration arranged by a committee of the association in connection with the educational section. The botanical section is arranging a special exhibit, whilst collections illustrating the work of the various corresponding societies are being arranged in conjunction with the Cardiff Naturalists' Society.

A reception, specially intended for the members of Section I, will probably be given by Prof. J. Berry Haycraft in the new physiological laboratories of the medical school.

The list of foreign guests who have accepted the invitation to be present includes the names of MM. Bruno and Brioux, representing the French Department of Agriculture; Profs. Cayeux, Laplae, Fauvel, and Yves-Guyot, from France; Prof. Gilson, from Brussels; Profs. Chamberlin, Graham Lusk, and Kofoid, from the United States; Prof. Chodat, from Geneva; Profs. Hasselsbalch and Ostenfeld, from Denmark; and Don. G. J. de Osma, from Madrid.

Obituary.

PROF. J. R. RYDBERG, FOR.MEM.R.S.

PROF. J. R. RYDBERG, who died in December last after a long illness, made an enduring contribution to science by his investigations of the arrangement of lines in the spectra of the elements. Rydberg was one of the earliest workers on this subject, and he entered upon it with a full realisation of its significance in relation to the structure of atoms and molecules. His classical memoir, "Recherches sur la Constitution des Spectres d'Emission des Eléments Chimiques," was presented to the Swedish Academy in 1889, but he appears to have arrived at his well-known general formula before the announcement by Balmer, in 1885, of the formula connecting the lines of hydrogen.

Notwithstanding the imperfect spectroscopic tables then at his disposal, Rydberg discovered most of the important properties of series spectra, including the relation between corresponding series in the spectra of related elements, and foreshadowed discoveries which were made later, when experimental work had sufficiently advanced. Some of the features noted by Rydberg were observed about the same time by Kayser and Runge, but his work had the special merit of connecting different series in the spectrum of the same element into one system, which could be represented by a set of simple formulæ having but few adjustable constants. He especially insisted that the hydrogen constant, now generally called the "Rydberg constant," should appear in the formulæ for all series, and, apart from slight variations from element to element suggested by the theoretical work of Bohr, nearly all subsequent attempts to improve the representation of series have involved this supposition, and have had Rydberg's formula as a basis.

Other valuable contributions to the subject were made by Rydberg, but the memoir above mentioned is the most comprehensive of his published papers; it is a perfect model of a scientific investigation, and may still be read with advantage by all students of physics.

Much attention was also given by him to the chemical and physical properties of the elements in relation to the periodic system, and in 1913 he published his suggestive memoir, "Untersuchungen über das System der Grundstoffe." His later work in this connection was seriously interrupted by ill-health.

Rydberg was born at Halmstad, in Sweden, on November 8, 1854, and entered the University of Lund in 1873. He obtained the doctor's degree in mathematics six years later, and after holding appointments in the departments of mathematics and physics, was appointed professor of physics in the University in 1901. About a month before his death he had retired from his professorship on reaching the age-limit of sixty-five years. He was elected a foreign member of the Royal Society in 1919.

THE death is announced of PROF. A. A. INOSTRANSEFF, who was for many years professor of geology in the University of Petrograd. Inostranseff was born in 1843, and began his geological researches in Germany, where he was led to devote special attention to petrology. His first paper, on the microscopic structure of some Vesuvian lava, was published at Halle in 1872. On his return to Russia he made important observations on the opaque minerals in crystalline rocks and on the metamorphic rocks of the Government of Olenez. He also did much geological surveying in the Caucasus in connection with projected railways. His interests gradually widened, and in 1882 he published a volume (unfortunately in the Russian language) on man in the Stone Age round Lake Ladoga. He had much success as a teacher, and among other researches which he encouraged may be particularly mentioned those of his pupil, the late Prof. Amalitsky, on the Permian deposits of northern Russia. The Permian theriodont reptile Inostransevia commemorates his name.

WE regret to announce the death, on June 19, of Dr. F. A. Tarleton, senior fellow of Trinity College, Dublin, a former professor of natural philosophy, and president in 1906 of the Royal Irish Academy.

Notes.

By the gracious command of the King, the Society of Tropical Medicine and Hygiene, which was founded in June, 1907, will henceforth be known as "The Royal Society of Tropical Medicine and Hygiene."

We recorded last week that at the anniversary meeting of the Linnean Society on May 27 the gold medal of the society was handed by the president to Sir Ray Lankester, to whom it had been awarded by the president and council. The president's anniversary address was devoted to an account of our present knowledge of the earliest known fossil fishes —the Ostracoderma—in the investigation of which Sir Ray Lankester was a pioneer, his monograph on Cephalaspis and Pteraspis having been published by the Palæontographical Society in 1870.

The first gold medal ever given by the Institution of Sanitary Engineers was presented at the annual summer meeting of the institution last week to Major A. J. Martin "for his services in originating Health Week and in the development of civil and military sanitation before and during the war."

Mr. Marconi, who has just returned from Italy by sea, has favoured us with the following appreciative reference to the late Prof. Righi:—"Although I never had, as is often stated, the privilege of being a pupil of Prof. Righi, I have always had, as is well known, a very deep admiration for him and for his great and far-reaching work in connection with physics, and particularly electric waves. Prof. Righi, whom I knew well personally, was a man of singularly unassuming character, and by his death not only has Italy lost one of her foremost scientific men, but the world also loses a brilliant and original worker in the field of electrotechnics."

Dr. F. G. Cottrell, Director of the U.S. Bureau of Mines, has been awarded the Willard Gibbs medal of the Chicago Section of the American Chemical Society.

The annual summer meeting of the Anatomical Society of Great Britain and Ireland is to be held at Cambridge on July 2 and 3. Papers on the morphology and development of the central nervous system have been promised, and there will be discussions on the structure of the earliest land vertebrates, the partial transposition of the mesogastric viscera, and avian structure as bearing upon problems of bird migration.

We are informed by the Secretary of the Department of Scientific and Industrial Research that the Research Association for the British Motor Cycle and Cycle Car Industry has been approved by the Department as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. As the association is to be registered as a non-profit-sharing company, the promoters have applied to the Board of Trade for the issue of a licence under Section 20 of the Companies (Consolidation) Act of 1908. The secretary of the committee engaged in the establishment of this association is Major H. R. Watling, "The Towers," Warwick Road, Coventry.

At the eighty-sixth annual general meeting of the Royal Statistical Society, held on June 15, the following elections took place:—*President:* Sir R. Henry Rew. *Treasurer:* Mr. R. Holland-Martin. *Honorary Secretaries:* Mr. A. W. Flux, Mr. M. Greenwood, and Sir J. C. Stamp. *Honorary Foreign Secretary:* Mr. R. Dudfield. *Council:* Mr. W. M. Acworth, Dr. J. Bonar, Dr. A. L. Bowley, Miss Clara E. Collet, Major L. Darwin, Mr. G. Drage, Mr. R. Dudfield, Mr. A. W. Flux, Sir D. Drummond Fraser, Mr. J. H. Gorvin, Mr. M. Greenwood, Sir Robert Hadfield, Bart., Sir Edgar J. Harper, Mr. R. G. Hawtrey, Sir H. E. Haward, Mr. R. Holland-Martin, Dr. L. Isserlis, the Right Hon. F. Huth Jackson, Mr. A. W. W. King, Mr. H. W. Macrosty, Mr. E. R. P. Moon, Sir Shirley F. Murphy, Mr. H. V. Reade, Mr. C. P. Sanger, Dr. E. C. Snow, Mr. J. C. Spensley, Sir J. C. Stamp, Sir A. D. Steel-Maitland, Bart., Mr. T. H. C. Stevenson, and Mr. H. Withers. It was announced that the Guy medal in gold had been awarded to Dr. T. H. C. Stevenson.

Mr. Julian Baker has been re-elected chairman of the London Section of the Society of Chemical Industry, and Dr. Monier Williams is to take the place of Dr. S. Miall as honorary secretary, Dr. Miall having resigned the position. The new members of the committee are Mr. A. Chaston Chapman, Mr. J. Conner, Mr. A. H. Dewar, Dr. B. Dyer, and Prof. W. R. E. Hodgkinson.

The U.S. National Research Council, a co-operative organisation of leading scientific and technical men of the country for the promotion of scientific research and the application and dissemination of scientific knowledge for the benefit of the national welfare, has elected the following officers for the year beginning July 1:—*Chairman:* H. A. Bumstead, professor of physics and director of the Sloane Physical Laboratory, Yale University. *First Vice-Chairman:* C. D. Walcott, president of the National Academy of Sciences and secretary of the Smithsonian Institution. *Second Vice-Chairman:* Gano Dunn, president of the J. G. White Engineering Corporation, New York. *Third Vice-Chairman:* R. A. Millikan, professor of physics, University of Chicago. *Permanent Secretary:* Vernon Kellogg, professor of biology, Stanford University. *Treasurer:* F. L. Ransome, treasurer of the National Academy of Sciences. The Council was organised in 1916 under the auspices of the National Academy of Sciences to mobilise the scientific resources of America for work on war problems, and re-organised in 1918 by an executive order of the President on a permanent peace-time basis. Although co-operating with various Government scientific bureaux, it is not controlled or supported by the Government. It has recently received an endowment of five million dollars from the Carnegie Corporation, part of which is to be expended for the erection of a suitable building in Washington for the joint use of the Council and the National Academy of Sciences. Other gifts have been made to it for the carrying out of specific scientific researches under its direction.

DR. R. S. MORRELL has been elected president of the Oil and Colour Chemists' Association in succession to Dr. F. Mollwo Perkin.

DR. V. H. MANNING, lately director of the U.S. Bureau of Mines, has been appointed director of research in the American Petroleum Institute.

DR. J. R. ANGELL, chairman of the U.S. National Research Council and professor of psychology in the University of Chicago, has been elected president of the Carnegie Corporation of New York.

MR. E. C. R. ARMSTRONG describes in the June issue of *Man* an interesting acquisition by the Royal Irish Academy of two penannular rings with cup-shaped ends, two bracelets, and an elaborately decorated disc—all of gold—found last year in a bog in Co. Cavan. The gold disc is of special value. The ornamentation, which was probably made by pressing the gold plate into a bronze matrix, is so fine that it is scarcely going too far to describe it as the most delicately decorated gold object belonging to the Bronze age that has up to the present been acquired by the Irish National Collection. The use of these discs has been a matter of doubt, but we have a parallel in a bronze specimen found at Trundholm Moss, in the north of Zeeland, and another of Irish origin in the British Museum. The ornamentation is probably connected with sun worship, but the Cavan discovery is of additional importance in that now for the first time a gold disc has been found in Ireland associated with objects, such as the gold rings and bracelets, which can be dated in the later portion of the Bronze age.

IN the same journal Mr. J. Reid Moir describes the discovery of an early Neolithic "floor" in the neighbourhood of Ipswich. On the surface of the gravel underlying a stratum of peat a flint implement of grey material, not rolled or patinated, representing a well-recognised type of an early Neolithic axe of the chipped and polished variety, was unearthed. In association with this, flakes, apparently of the Mousterian order, almost certainly more ancient than the Neolithic axe, were discovered. The mammalian bones associated with the "find" were examined by Prof. Arthur Keith, who identifies two varieties of the horse, large and small, of oxen, red deer, a wolf or large dog, pigs, and sheep. The horse-bones had been smashed up, apparently for the extraction of marrow.

IN *Sudan Notes and Records* (vol. iii., No. 2, April, 1920) the Rev. D. S. Oyler describes the Shilluks' belief in medicine men. They undergo a rite of initiation. A fact of interest connected with them is that "many of the medicine men have physical defects, their children are usually rickety, and many of them are deformed. The natives say that this is caused by the fact that the shades of his victims bring a curse on the medicine man, and also on his family." Few Shilluks will admit that they believe in his powers, but they seek him constantly, and their whole manner of life is influenced by the witch doctor. "So long as the Shilluks are dominated by the medicine men they will make very slight advancement in their mode of thought and their manner of living."

THE twenty-sixth Report of the Danish Biological Station to the Board of Agriculture (Copenhagen, 1919) contains two valuable memoirs. The first, by Mr. P. Boysen Jensen ("Valuation of the Limfjord, I.: Studies on the Fish-food in the Limfjord, 1909–1917"), summarises the work of several years based on valuations of the bottom invertebrate fauna with its special significance as fish-food. The study of the amount of food present in each year, its variation, rate of growth, and connection with the plaice fishery, shows interesting results. The fauna varies from year to year in both amount and kind, and the breeding seasons of the most important species differ, some breeding yearly, others apparently only once in several years. A careful comparison of the annual production and consumption shows that in certain areas the food is not sufficient to support an unlimited transplantation of plaice, and that the years which were specially bad for fishing were those in which there was an unusually small amount of food available. Prof. C. G. J. Petersen, in the second memoir ("Our Gobies (Gobiidæ) from the Egg to the Adult Stages"), adds much to our knowledge of the young stages of these little fishes, so numerous in our seas and so difficult to identify in their early life. We note with satisfaction that he finally allows the specific value of *Gobius minutus* and *G. microps*, hitherto usually regarded as distinct forms of one species, and shows that they can be distinguished throughout their life by skeletal features and by pigment. The very beautiful plates, both coloured and plain, illustrating the various stages in the life-history of the Danish gobies add much to the value of this work.

IN part iii. of their remarkable series of memoirs on Old Red Sandstone plants from the Rhynie chert-bed of Aberdeenshire (not younger than Middle Devonian) Dr. Kidston and Prof. Lang give a full and abundantly illustrated account of a third generic type, *Asteroxylon Mackiei*, of vascular Cryptogams discovered by Dr. Mackie, who figured a single transverse section of the stem. Like Rhynia and Hornea, Asteroxylon was a terrestrial plant which grew in a peaty soil. The subterranean portion of the plant consisted of slender rhizomes, 1–6 mm. in diameter, without absorbent hairs, having a broad cortex differentiated into an outer and an inner zone, and a simple vascular strand of spiral tracheids surrounded by a cylinder of phloëm. Branches of the rhizome passed through a transitional region characterised by the presence of scale-leaves into aerial foliage shoots 1 cm. to 1 mm. in diameter, bearing numerous spirally disposed small leaves; and it is probable that certain slender leafless branches occasionally associated with them represent fertile shoots which bore pear-shaped terminal sporangia without an annulus, and dehiscing at the broad free end. No actual connection between the leafless axes and sporangia or between either and the shoots of Asteroxylon has been demonstrated, but there is little doubt that they were parts of one plant. The vascular cylinder of the

leafy shoots had a stellate stele, and from the enlarged ends of the arms small concentric leaf-traces were given off, which passed to the base of each leaf but never entered the free lamina. In habit Asteroxylon agrees closely with the well-known older Devonian plant, *Psilophyton princeps*, and to a rather less extent with Psilotum. It throws light on the morphology of certain Devonian plants known only as impressions, and raises many questions of theoretical interest which are discussed by the authors.

NEW light on several problems of Arabian geography has resulted from the war. In the *Geographical Journal* for June (vol. lv., No. 6) Dr. D. G. Hogarth deals with certain discoveries in the Hejaz. It has now been found that the watershed between drainage west to the Red Sea and north-east to the Persian Gulf lies further east than was previously supposed. Its exact course has still to be traced, but it certainly lies some distance back from the coast and runs through the Kheibar *harra* east of the Hejaz railway. Further south in Asir it comes nearer the Red Sea. Much material has been collected for the mapping of the Hejaz, especially in the north, against the Gulf of Akaba, and further south between Wejh and Rabugh. The intervening block, except for the littoral, is most imperfectly known. Considerable additions have also been made to our knowledge of the coast-line between Akaba and Aden. Dr. Hogarth concludes his paper by summarising some new information about Medina, of which a Turkish plan and several photographs have now been obtained. A British aeroplane which flew over the city secured a photograph of the railway station and immediate surroundings, but strict injunctions were given not to photograph the Haram or Great Mosque which contains the Tomb of the Prophet. The photograph secured on this occasion is reproduced, among others, with the paper.

THERE seems now to be evidence that so far back as the beginning of the Cambrian period conditions in the sea round the South Pole were not very favourable to life. In a piece of Lower Cambrian limestone dredged by the Scottish Antarctic Expedition from the bed of the Weddell Sea, and in other fragments of the same rock from the moraine of the Beardmore glacier on the opposite side of the South Pole, numerous remains of the sponge-like Archæocyathinæ have been found closely similar to those discovered in a corresponding formation in South Australia. All the Antarctic forms, however, are comparatively dwarfed, and show various thickenings and irregular additions to the skeleton which denote a struggle with adverse conditions. The specimens are described in great detail, with excellent illustrations, by Dr. W. T. Gordon in the Transactions of the Royal Society of Edinburgh (vol. lii., part iv.), but they do not throw any new light on the affinities of these remarkable fossils. They are associated with ordinary spicules of sponges, fragments of shells and trilobites, and a considerable growth of calcareous algæ.

THE *Museums Journal* for June welcomes the chance of increased co-operation between the University and the British Museum that would be afforded by the new site offered to London University, but points out that concentration is not altogether to the advantage of students arriving from the various residential districts, and that concentration in a restricted area will check the inevitable expansion of both University and Museum. This enforces, from another aspect, the argument put forward by Sir E. Sharpey Schafer in NATURE for June 17.

THE advances made in wireless telegraphy and telephony during the war were enormous, and in all the three fighting Services it has established itself as indispensable. A large section of the Signals experimental establishment at Woolwich is now devoted to the development of equipment to meet the requirements of the Army, which differ in several respects from those of the Navy or Air Force. Much of the apparatus has to be specially compact and mobile, and for the circumstances of modern warfare the quantity of messages to be dealt with in a short time renders high speed of transmission essential. The adaptation of the Wheatstone automatic transmitter, working from a previously punched paper strip, to wireless working enables speeds of transmission from 450 to even 1000 words per minute to be attained. The small currents through the contacts which are sufficient for wireless apparatus render the conditions particularly favourable for high speeds. Particular attention is given to the linking-up of line with wireless systems. High-speed messages come in over the wire in the ordinary way, and are automatically handed over to the wireless apparatus without loss of time in retransmission. Another recent development of wireless working, finding particularly useful application in the Army, is direction-finding, and very compact sets for this purpose with a range up to 250 miles are now being standardised at Woolwich. A point to which special experiment is being directed is the obtaining of a high degree of selectivity by which extraneous waves from near and far can be "tuned out" and the feeblest messages of the required frequency amplified to the extent necessary for satisfactory reception.

THE Deutsche Seewarte is resuming its activity in the direction of publications. We have received a report for the five years 1914–18, thirty-seventh to forty-first year of the institution, and with it an overdue report published in 1914 of a survey voyage of S.M.S. *Möwe* in 1911 to the West Coast of Africa. The course was from Wilhelmshaven to Ferrol, Cadiz, Teneriffe, Dakar, Freetown, Lome, Lagos, Lome, Accra, Lome, Duala, Banana, Boma, Swakopmund, and Lüderitzbucht, the last being reached on October 7, 1911. The expedition went up the Congo as far as Boma. Observations were taken of the depth of the sea and of the currents, temperature, density, and salinity at different depths down to 2000 metres. This oceanography, divided into the three sections, North-West, Equatorial, and South-West Africa, was directed by Drs. G. Schott and B. Schultz. A meteorological log was kept by Dr. P. Perlewitz, including some kite observations. The regular observations were taken at intervals of four hours, whether in harbour or on voyage, and the elements tabulated, in addition to the latitude and longitude, are direction and force of the wind, barometer,

dry- and wet-bulb temperature, relative humidity, cloudiness, sea-surface temperature, strength of current, and rainfall, with notes of any unusual phenomena, including the appearance of albatrosses and schools of dolphins or flying-fish. The charts included with the publication show the salinity and temperature in depth sections, the one for Mogador giving salinity, temperature, and density separately. The salinity seems to decrease southwards, and also generally with increasing depth.

THE March number of *Terrestrial Magnetism and Atmospheric Electricity* contains a summary, by Mr. J. P. Ault, of the results of the magnetic survey of the Atlantic made by the *Carnegie* during her voyage from Washington to Dakar, West Africa, and Buenos Aires during the autumn and winter. While the values found for the magnetic dip differ often by two or three degrees from those given in the last Admiralty Charts 3598, 3603, and 3775, the values of the observed deviation of the compass to the west differ by more than a few tenths of a degree from the charted values in certain limited regions only. Thus in the region between the Gold Coast and the Island of Ascension the Admiralty Chart gives the deviation to the west about one degree too large, and between Trinidad and Buenos Aires there is a considerable area in which the deviation is given too small by the same amount.

OWING to the decrease in research at Harvard during the war, vol. xiii. of Contributions from the Jefferson Physical Laboratory covers the three years 1916–7–8, and at least a third of the volume is devoted to Dr. P. W. Bridgman's work on the effects of pressure on the electrical resistance and thermo-electric properties of more than twenty metals. The pressures used reach 12,000 kilograms per sq. cm., and the temperature ranges between 0° C. and 100° C. With the exception of wires of bismuth and antimony, the resistances of metallic wires subjected to hydrostatic pressure decrease with the pressure, following a linear law approximately, and at 10,000 kilograms per sq. cm. have values about 99 per cent. of their values at atmospheric pressure in the case of cobalt and tungsten down to about 90 per cent. in the case of lead, tin, and cadmium. The temperature-coefficient of resistance remains almost unchanged. The effect of pressure on the thermo-electric properties is much more variable. The normal effect is to increase the thermo-electric power of the metal, but in three out of the twenty metals tried this is not the case. In most cases both the Peltier and the Kelvin effects are increased, but there are many exceptions. The author considers that the electron theory is quite incapable of explaining these results.

WE have received from Messrs. C. Baker, High Holborn, W.C., their classified list (No. 69) of second-hand scientific instruments. The list includes microscopes and accessories, telescopes and field-glasses, spectroscopes, surveying, astronomical, projection and physical apparatus, and contains particulars of more than 2000 pieces of apparatus. In these days of high prices intending purchasers would be well advised in the first place to consult Messrs. Baker's catalogue.

Our Astronomical Column.

MERCURY AN EVENING STAR.—The greatest elongation of Mercury (E. 25° 41′) occurs on June 29. On June 24 the planet will set at 9.54 G.M.T., or 1h. 34m. after the sun, and may possibly be detected close to the W.N.W. horizon by anyone with a good eye. A field-glass should render the planet distinctly visible about an hour after sunset.

THE ZEEMAN EFFECT IN FURNACE SPECTRA.—In continuation of his well-known researches on furnace spectra, Mr. A. S. King has recently been investigating the Zeeman effect for iron and vanadium in the electric furnace. Observations of the effect of a magnetic field on spectra have up to the present been chiefly confined to spark spectra, so that it is interesting to compare the effects when different sources are used. The electric furnace possesses, in addition, certain advantages over spark spectra for this purpose, since most of the low temperature lines are much more readily examined. Also, the inverse effect for absorption spectra is easily obtained by introducing a graphite plug to give a background of continuous spectrum. A description of the apparatus and results is given in the *Astrophysical Journal* for March. The furnace tube was placed parallel to the lines of force in a field varying from 6500 gauss in the centre to 9000 gauss near the ends, and observations were made of one hundred iron lines and ninety vanadium lines. The results of these preliminary observations seem to show that the effect is independent of the source used, since the observed separations agree both in character and magnitude with those of corresponding spark lines.

THE LUNAR PARALLAX AND RELATED CONSTANTS.—There is a set of quantities (the radius and figure of the earth, the intensity of gravity, the moon's parallax and the motion of her perigee and node) which are so intimately related that an alteration in one compels corresponding alterations throughout. Prof. W. de Sitter has endeavoured to obtain a mutually consistent series of values, and gives the results in vol. xvii. of the Proc. of the Royal Academy of Science, Amsterdam. It is impossible in a brief note to do more than give his conclusions.

Mean radius of earth—*i.e.* radius in geogr. lat. the sine of which is $\{\frac{1}{3}\}^{\frac{1}{2}}$=6,371,237 metres.

Value of gravity at that latitude (unaffected by centrifugal force), 9·82014.

π^1=sine moon's parallax/sine 1″=3422·544″.

Compression of earth, 1/296·0.

Constant of precession, 50·250″; luni-solar precession, 50·373″. Mass of moon, 1/81·50

$\frac{C-A}{C}$=0·0032775; where C, A are the principal moments of inertia of the earth.

Also, if A′, B′, C′ are the three principal moments of inertia for the moon, and

$$\alpha=\frac{C'-B'}{A'},\ \beta=\frac{C'-A'}{B'},\ \gamma=\frac{B'-A'}{C'},$$

β is found to be 0·000626, and $f=\frac{\alpha}{\beta}$=0·92.

This value of f is much larger than those previously found, which ranged from 0·49 to 0·75. In other words, the present paper makes the moon's equator less elongated towards the earth than previous determinations.

Prof. de Sitter's investigation reminds us of the late Prof. Harkness's "solar parallax and related constants." By a combination of all available evidence he deduced, nearly thirty years ago, a value of the solar parallax practically identical with that now accepted.

The Centenary of Sir Joseph Banks, Bart.

THE commemoration of the centenary of Sir Joseph Banks, Bart., who died on June 19, 1820, was celebrated by the Linnean Society on Thursday last, as mentioned on p. 496 of NATURE for June 17. After the usual formal business, Dr. B. Daydon Jackson read the first communication on "Banks as a Traveller," speaking of his four overseas voyages—first, the visit to Newfoundland in H.M.S. *Niger*, on board which his friend Constantine Phipps, afterwards Lord Mulgrave, was a lieutenant; next, the adventurous voyage of the *Endeavour*, Lieut. Cook commander, when Banks so amply proved his value in many untoward events; third, the voyage to Iceland; and fourth, his trip to Rotterdam in 1773, when he was still eager for an expedition to the North. The second paper, by Dr. A. B. Rendle, was entitled "Banks as a Patron of Science." Banks's life from his return to England in 1771 until its close in 1820 was that of an enthusiastic, liberal, and generally far-sighted patron of science. A friendship began with King George, which steadily increased, and Banks was consulted on important matters of very various kinds. He became botanical adviser to the King in relation to the Royal Gardens at Kew, which developed under Banks's guidance, becoming the repository of plants of economic and ornamental value from all parts of the world. Banks initiated or encouraged voyages of exploration, and kept up an extensive correspondence with men interested in science overseas. His house in Soho Square was the rendezvous of students and men of all classes interested in schemes of philanthropy or science; his magnificent library and herbarium were at the service of other workers, and after his death were bequeathed to the British Museum. For forty-two years he was president of the Royal Society. He was very closely, though indirectly, associated with the origin of the Linnean Society. Mr. James Britten, in the third paper, began by remarking that much of his paper was based upon the daily use of Banksian specimens for nearly half a century in the British Museum. The author showed that the popular belief that Banks left all his botanic work to his secretaries and curators, Solander and Dryander, was a mistaken one, and that Banks displayed great botanic acquirements.

The president remarked that official records of the British Museum testified to the active interest taken by Banks in all matters connected with its advancement, and that keepers and trustees alike referred to him for his advice and decision.

Certain objects closely connected with Banks were exhibited.

South-Eastern Union of Scientific Societies.

THE twenty-fifth annual congress of the Union was held at Eastbourne on June 2–6, under the presidency of Sir Edward Brabrook, who in his presidential address dealt with progress in anthropology and economics during the past quarter of a century. In regard to the latter, he expressed the opinion that the war seemed to have dismissed all economic orthodoxy into thin air, with unrestricted paper currency, reckless extravagance, trading by Government, and manipulation of markets, all of which had been borne with patience during war-time, but were intolerable in time of peace. Science had done what it could to provide sound instruction by the issue of standard works.

The second day's business began with a paper by Comdr. E. A. Martin on "The Glaciation of the South Downs," in which he endeavoured to show that the chalk hills received their final curving by ice-agency, and attributed much of the "clay-with-flints" deposits and the chalk rubble of the dry valleys to the agency of glaciers, having their rise on the Downs when they were at a greater height, with greater precipitation, and a low snow-line. He had mapped out the blocks of sandstones, ironstones, and sarsens, and concluded that short rivers could not have transported them to where they are now found. He compared the ironstones with similar deposits which have been found at Lenham, on the North Downs, to be of Pliocene age. He referred the rounded contours of the chalk hills to the grinding action of ice, resulting in their appearance now as huge *roches-moutonnées*. Striations were not, as a rule, found, because the rocks were such as would rather crumble and perish under the pressure necessary to produce them. One sarsen at Stanmer was found, however, distinctly to be striated. The author thought that there had been two clear periods of glaciation: one before the deposition of the temperate marine muds at Selsea, at the base of which were the famous Selsea erratics, referable to the glaciation at the close of the Acheulian period, and a later one which gave rise to the Rubble-Drift, after the development of the Mousterian culture. In a brief discussion which followed, the glaciation theory was opposed by Mr. T. Sheppard, of Hull.

Mr. C. C. Fagg read a paper on "First Steps in a Local Regional Survey," in continuation of the efforts which he has made for some years to stimulate the regional survey movement. Prof. Boulger, in the absence through illness of Miss G. Lister, read a paper on "The Eastern Extension of the Lusitanian Flora," with special reference to the locality.

Prof. E. B. Poulton delivered a public lecture on "Mimicry and Migrations of Insects," and this was attended by invitation by numerous boys' and girls' schools in the town. A paper was read by Mr. R. Adkin on "Migrations of Butterflies and Moths in regard to the British Islands." Mr. Adkin dealt with flights of migrating Lepidoptera and movements of larvæ by the agency of the wind, and discussed the question of whether such occurrences are to be considered as chance happenings or as the result of voluntary action on the part of the migrants. Some account was given of observed immigrations on the coast near Eastbourne, and further evidence was asked for. Mr. Adkin showed how the geographical position of the British Islands rendered them singularly suitable for the observation of such phenomena, and suggested the lines of movement by which such immigrants would be likely to reach our coasts. The paper was illustrated by maps and diagrams and by exhibits of the insects referred to.

The matter of the enclosing of so much of the Downs during the last year or two by barbed-wire fences was discussed, and a resolution was carried with much enthusiasm asking that joint steps should be taken by several influential bodies to carry through a scheme for the protection of rights of way over the Downs, and for the acquisition for public use of typical stretches of them.

A large collection of wild flowers was on exhibition during the congress. *Phyteuma spicatum* was said to be growing in large quantities in East Sussex this year, and orchids were found in profusion in and about Beachy Head. Excursions to Pevensey, Alfriston, East Dean, Old Eastbourne, and other places added interest to a very successful congress.

After one of the excursions the party returned to "Hodeslea" to tea. Huxley spent the later years of

his life in Eastbourne, and occupied "Hodeslea," which is now the residence of the Union's treasurer. The house was built by Huxley in 1890 and he lived there until 1895, whilst his widow remained there until her death in 1914. Mr. Adkin has recently placed a bronze tablet on the house relating these facts.

Genetic Segregation.[1]

By W. BATESON, F.R.S.

LATER developments of genetics have been, in the main, attempts to discover the nature and scope of *segregation*. Mendel proved that certain characters are determined by unit-factors. Their integrity is maintained by segregation, the capacity, namely, to separate unimpaired after combination with their opposites. We have been trying, first, to ascertain specifically what characters behave in this way, whether there is any limit to the scope of segregation or any classes of characters otherwise transmitted. Among characters known to be subject to segregation are illustrations of most of the features by which plants and animals are distinguished. In regard to two classes of characters the evidence for segregation is, nevertheless, rather noticeably imperfect. No quite clear proof exists that differences in number—*meristic* characters in the strict sense—are governed by factors comparable with those that control, for example, colour. The extra toe of the fowl and the single leaflet of the monophyllous strawberry are perhaps the best examples, but reservations may be entertained. Also, though segregation can be demonstrated in regard to *quantitative* characters, parental types thus distinguished often fail to re-appear, and the inheritance is subject to special complications.

Groups or complexes of factors are now recognised as sometimes segregating whole. Were it not that on occasion elements of the complex become independent, the group would pass for one unit-factor. The sex-complex is an obvious example. Intermediate flower-colours, like those of modern sweet peas, probably arise by this process. The plausible suggestion that the new terms are only rare cross-overs in a closely linked series does not fit the evidence. A striking illustration appears in Œnothera, in which, as Renner lately showed, several groups of characters normally segregate as single factors. These complexes are in several forms not borne equally by the two sexes of the plant, and most of them cannot exist in the homozygous state. By these discoveries the Œnothera problem is greatly elucidated.

The second question is to determine when in the life-cycles segregation can occur. Admittedly it is a phenomenon of cell-division. If we knew the animals only we might confidently adopt the view of Morgan that normal segregation happens during the maturation process at the stage of synapsis, when the maternal and paternal chromosomes are believed to conjugate in pairs. Most of the facts of linkage may be thus well represented, but the absence of crossing-over in the sex-heterozygote (Drosophila and silk-worm) is not readily explicable, nor is there as yet extensive evidence that the number of linkage-systems agrees with that of the chromosomes—a primary postulate of Morgan's theory. The evidence for an orderly anastomosis, or even of any exchange of materials between chromosomes, is weak; and the visible features of chromosomes are scarcely suggestive of the prodigious heterogeneity requisite. Even if the linkage-systems correspond with the chromosomes, which is a most attractive conjecture, exchange of material between chromosomes need not be essential to crossing-over. It may be doubted, however, whether the general course of cytological evidence does not point to the *rôle* of the chromosomes being rather passive than active.

That in plants segregation even in its normal course is not limited to the reduction-division is now certain. In Matthiola, Campanula, Begonia, and Œnothera the genetic composition of the male and female organs may be normally different, and segregation cannot have happened later than the constitution of these organs. This kind of segregation must result in *Campanula carpatica* (experiments of C. Pellew) and in *Begonia Davisii* from the peculiar genetic properties of the female complex, for it re-appears in offspring derived from the female side for several generations at least, but not among those derived from the male side. Collins's evidence from Funaria proves further that sex-segregation may happen during the growth of a haploid form.

Periclinal chimæras and the production of distinct types from adventitious buds prove that segregation may take place during somatic development, whether in the differentiation of the layers or of the root. In the genetic properties of the tare-like rogues of peas there are features which not only illustrate the occurrence of gradational change in genetic properties, following somatic differentiation, but also show that this gradation affects the male and female organs differently. From these facts it must be concluded that normal and orderly segregation (apart from chance sporting) can occur at various cell-divisions, and not exclusively at reduction. Not impossibly these somatic segregations may be accompanied by some visible cytological differentiation, but that question must not be prejudged.

Having regard to the fundamental distinctions between the morphological relations of the germ-cells to the soma in animals and in the flowering plants, it is not surprising that the processes of segregation should be differently effected in these two groups of organisms.

[1] Abstract of the Croonian Lecture delivered before the Royal Society on June 17.

Colour Index of the British Isles.

AT a meeting of the Royal Anthropological Institute held on June 15, Prof. Arthur Keith, ex-president, in the chair, Prof. F. G. Parsons read a paper on "The Colour Index of the British Isles." He first reviewed the different ways of constructing an index of nigrescence, and directed attention to what he considered their weak points. Prof. Parsons proposed as a simple and workable index that the percentage in any group of individuals with dark brown and black hair should be added to the percentage with eyes in which any brown pigment is present, and the result divided by two. For practical purposes he found it better to record the percentages of dark hair and dark eyes separately. He then proceeded to examine the large mass of statistics collected by Dr. Beddoe in the middle of the last century, and pointed out that the first deduction was that women are in the mass darker than men, and that where the people are fairest the difference between the sexes is greatest, as the following table shows:

	No. of records	Index		Diff.
		Men	Women	
4 Northern Counties ...	1767	26·2	33·5	7·3
3 Eastern ,, ...	1563	34·4	38·2	3·8
2 Western ,, ...	4057	45·5	46·7	1·2

It therefore became necessary to exclude those

records of Beddoe in which the sexes had not been kept separate. Fortunately, however, nearly fifteen thousand records on males alone remained available. In the Northern and Eastern Counties, in the lowlands of Scotland, and again in Sussex and Hampshire, the correspondence of the tracks of the hair and eye indices was most marked, whilst in the Western and West-Central Counties, in Wales, and in the Highlands of Scotland the darkness of the hair was very much greater than that of the eyes. It was pointed out that those regions in which the hair and eyes correspond in lightness were historically regarded as the sites of the purest Nordic blood in these islands, while those parts in which the hair track was much higher than that of the eyes were the sites in which we have every reason to believe the Mediterranean blood had mixed most freely with the Nordic. Where the two races had mixed it appeared that the light Nordic eyes and the dark Mediterranean hair were the dominant factors. Except in Wales, a percentage of more than 50 dark eyes is unknown in the British Isles.

On comparing town and country dwellers it was noticed that the towns were darker than the country, except in those parts where the nigrescence was very high, when the reverse was the case. It was suggested that one reason for this might be that the town dwellers were more migratory than those of the country, though probably this did not account for all the difference

The distribution of red hair was worked out and found to be greatest in Scotland and the North of England, where the nigrescence was least. It was also pointed out that the evidence available showed that it was more prevalent among the upper than the lower classes, and that this probably coincided with a lower index of nigrescence in the upper than in the lower classes.

In opening the discussion, Prof. Keith said that Prof. Parsons's paper was of supreme importance to all who were interested in the origin of the peoples of this country. In his opinion, pigmentation was probably the key to the problem, and Prof. Parsons's new method of estimating nigrescence was a real contribution to the study of the subject. His index was, however, in a sense, an average, and must therefore be used with caution. In referring to the lack of correspondence between hair and eye colour, he instanced the dark hair found in conjunction with grey eyes in Wales, Ireland, and West Scotland—a conjunction also occurring in Scandinavia. After thirty years of observation, however, he himself was still in doubt as to the difference between a Celt and a Saxon, and felt it impossible to distinguish between individuals from, say, Suffolk and Connaught. In his view the basis of the population of these islands was predominantly Nordic.

Dr. Brownlea said that he considered the results based upon the distinction of sex were not quite trustworthy. He held that six distinct races went to make up the population of these islands, one of these being a distinct red-haired race.

Mr. H. Peake, while agreeing with Prof. Keith that averages were untrustworthy, said that Prof. Parsons's index was not quite an average, and in any case it was the best method of dealing with observations which had been advanced so far. The conjunction of dark hair and light eyes was a puzzle. Was it due to a tendency in the Mediterranean race towards light eyes, or was it due to a fusion between the Nordic and Mediterranean types? Certain characters seemed to follow sex, and in cases where there had been an immigrant male population intermarrying with the females of the country, the dominant character of the male reappeared in the male line. Prof. Parsons's results pointed to this, in that where there was a considerable Nordic influence there were wide sex differences; where Nordic influence was small there was little difference between the sexes. He pointed out that not all red-haired people were alike in shape and colour. It had been suggested that red was a variant of fair hair, *e.g.* in Scandinavia. The older theory was that it was a border-line colour between fair and black. In Ireland, Wales, and Scotland it might arise from a crossing of Nordic and Mediterranean types. On the other hand, in the North of England it might be a variant of fair hair, as in Scandinavia. But even Scandinavia, he pointed out, was not homogeneous; light and dark types occurred, and therefore in that country also red hair might be due to contact.

Dr. Shrubsall said that in his investigations of the incidence of dark hair in town populations he had found that the longer the town history of a family, the darker the hair. He pointed out that the occurrence of red hair in the March country of Ireland, Wales, and Scotland supported the view that it was due to contact of light and dark types.

Dr. Stannus said that while investigating albinism in Africa he had found a large number of red-haired individuals, but in these cases the pigment was always found in solution. The problem was biochemical, and, in his opinion, microscopical examination was essential to show whether individual cases were cases of black hair in which the pigment had not been thrown out in granular form.

The chairman, in bringing the meeting to a close after Prof. Parsons had briefly replied, said that the discussion had shown the desirability of a much wider survey of the people than had hitherto been made. The results would have an important bearing upon such questions as the relation between health and race. He hoped that the Government might be induced to help in this great undertaking.

Army Hygiene and its Lessons.[1]

By LT.-GEN. SIR THOMAS GOODWIN, K.C.B.

UNTIL quite recent years it has never been sufficiently recognised that a very large proportion of Army medical effort should be directed towards the prevention of disease. The fact that in all wars in the past more men died from disease than from enemy action appears to have been accepted more or less with resignation, and regarded as inevitable. During the later years of the nineteenth century the increasing advances in science and our more exact knowledge regarding the ætiology and transmission of infective diseases led many medical officers to attempt to create barriers against the spread of disease by known paths, but there was a lamentable lack of co-ordinated effort.

Towards the close of the eighteenth century we begin to glean something in the nature of figures regarding sickness in armies in the field. In 1792 the allied Austrian and Russian armies were in Champagne; they commenced their retreat on September 30, and by the end of October had evacuated France, and during that short month, without any considerable fighting, they lost 25,000 men, or more than one-fourth of their number, every village being filled with dead and dying.

Accurate figures are unobtainable regarding Napoleon's campaign in 1812, but we learn that in June, 1812, he crossed the Niemen with a magnificent army

1 From three Chadwick Lectures delivered on March 8, 15, and 22 entitled "Army Hygiene prior to the Recent War," "Army Hygiene during the Great War," and "Army Hygiene in the Future."

of 400,000 men; he reached Moscow on September 14, the retreat began on October 19, and on December 13 he recrossed the Niemen, and of his great army more than four-fifths had melted away.

Probably one of our most disastrous campaigns, from a hygienic point of view, was the Walcheren Expedition of 1809, where our mortality from disease amounted to 346·9 per thousand of strength of troops.

Regarding the Crimean campaign in 1854 I shall say but little; we have all read of the trials and hardships of the troops in that campaign, in which the mortality from disease amounted to 230 per thousand of the strength.

In the Afghanistan War of 1878–80 the mortality was 93·7 per thousand, which appeared to be an improvement compared with the terrible figures which we have just considered.

Bad as these figures are, yet those of other nations are even more unfavourable; for example, in the French Sudanese campaign of 1888–89 the mortality from disease amounted to 280 per thousand—worse figures than those of our own Army in the Crimean campaign thirty-five years previously.

I think that perhaps the most striking example of the havoc which may be wrought by disease on an army in the field is that furnished by the French Army in Madagascar in 1895, where the mortality from disease amounted to 300 per thousand of strength. In this campaign 7 men were killed by the enemy and 94 wounded, while the deaths from disease numbered 5600. The actual admissions for sickness amounted to more than 15,000, or 85 per cent. of the whole force.

The evils in the past were mainly due to lack of co-ordination and of real knowledge on which concerted action could be based. Nevertheless, advances were made, and, as an example of the steady, progressive improvement in the health conditions of the soldier and the increased success in disease prevention, it is interesting to note that in India during the five years 1878–82 the following were our sickness and mortality rates per thousand of men serving among European troops:

	Constantly sick	Deaths	Malaria	Dysentery	Cholera
1878–82	68·1	20·5	569	42·8	5·7 (4·2 deaths)

Compare these figures with those for 1912:

1912	28·8	4·6	82	5·2	0·3 (0·2 deaths)

As regards conditions in the civil community, probably the first really important step towards an improved condition of affairs in England dates from the passing of the Public Health Act in 1875. Two hundred years ago the annual death-rate in London was 80 per thousand; I think it is now about 18 per thousand.

Military hygiene differs little in theory from that relating to the public health of a civil community, and in times of peace is closely allied to that ordinarily carried out in all branches of the Public Health Services.

There are, however, certain considerable advantages in military hygiene which find no counterpart in civil life. The measures which the sanitary officer recommends, when accepted, are carried out with all the power of military organisation and discipline behind them, and insanitary conditions and disease are subject to a far greater control than can usually be obtained with a civil population; so that, before the South African War, great advances had been made in the status and training of the Medical Service generally, but there were still many defects, the chief of which were lack of organisation in the Sanitary Service, deficient education and training in hygiene of the officers and men of all branches of the Service, and lack of co-ordination between the Medical Service and the rest of the Army.

Now let us consider the South African War. From what I have said you will realise that we entered on that war fairly equipped with knowledge, but with a deficiency of organisation as regards the hygienic requirements of an army in the field. It is true that affairs improved very considerably during the course of the war, but the unpreparedness at the outset bore its inevitable harvest. During this campaign some 14,000 men died from disease as compared with about 7000 killed. As regards enteric fever, we had 57,684 cases with 8022 deaths. Dysentery alone accounted for 86 admissions per thousand of the strength, and from all diseases we suffered 843 admissions with 24 deaths per thousand of the strength; while wounds in action accounted for 48 admissions with slightly less than 3 deaths per thousand.

South Africa saw the dawn of the organised scientific study of disease as regards its actual incidence in the field. Much of the success achieved by field hygiene and sanitation in the recent war may be traced to experience gained in the war in South Africa.

The Army Medical Service emerged from the South African War convinced of the absolute necessity for improving the sanitary organisation on certain definite lines. It was, in fact, at last generally realised throughout the Army that in war nothing is so costly as disease. The main requirements were, first, the *education* of the troops themselves—officers, non-commissioned officers, and men—in the aims and methods of hygiene. The second necessity indicated was the allocation of certain officers and *personnel* for sanitary work alone, and for their special training, in addition to the continued training of all medical officers, in the very latest scientific work. The third, and perhaps the most important, requisite was *organisation for war*.

This organisation was so arranged as to compass a thorough sanitary control of the lines of communication in order to filter off unfit men suffering from contagious or infective disease, and at the same time to maintain a freedom from disease of all *personnel* passing through the various channels and fixed establishments comprising the lines of communication. In France, for example, during the past war, it may be said that, beyond an outbreak of dysentery at one training centre, clearly traced to an influx of "carriers" from the East, the lines of communication during the whole period were maintained almost free from outbreaks of epidemic disease of any serious or extensive nature.

How very different were the conditions under which the Army took the field in 1914 from those of former wars! The scientific investigations of the preceding years had stabilised to a very large extent the hygienic environment of the soldier. Careful work on his foodstuffs as regards quantity, variety, and quality assured him a sound basis on which to wage war.

Undoubtedly much of the low incidence of infectious diseases enjoyed by the troops in the field during the whole war was due to a high resistance maintained by the ample and excellent condition of the food-supply. In the same way the equipment, clothing, and personal hygiene of the troops had all been envisaged on the soundest lines; while the method and practice of sterilising water-supplies and safeguarding foodstuffs, as well as the disposal of waste products, had been carefully thought out and generally inculcated.

Now let us consider the three main essentials to life, namely, food, water, and air. The *food* of the troops and its intimate relation to that important organ

"on which" (we are informed by high authority) "the army marches" likewise gave cause for the most careful study and preparation. In the past the military ration had been arranged upon more or less empirical lines after actual test marches. During the war, however, the menace of a national shortage of food and the importance of avoiding waste led to more exact studies of the needs of the troops by a detailed assessment of their actual energy output by the method of indirect calorimetry. Simultaneously with these studies, the assessment of the needs of the civil population by the Royal Society (War) Committee furnished information of incalculable value both for the future and, indeed, for the present time of world shortage.

It was a matter of no little difficulty to provide the many varied rations required by different peoples in different theatres at differing seasons and under varied military conditions; but, speaking generally, the Army of eight and a half millions had throughout been fed in such a manner as to enable it to fight effectively, to provide the energy and heat required, and to avoid outbreaks of disease traceable to the diet, with the exception of minor outbreaks of neuritis and scorbutic cases in those most distant areas—Mesopotamia and North Russia. In these localities the difficulty of at once arranging for local produce in severe climatic extremes and the dependence on preserved supplies from home were accountable for the outbreaks in question. Steps were quickly taken, however, to provide the necessary accessory food factors, at first by germinating pulses and by yeast, later by the intensive cultivation locally of fresh foodstuffs—measures which proved of great value both to the native inhabitants and to the troops.

The question of *water-supply* is one of the first importance. During the few years before the war experimental work on the various physical and chemical means of sterilisation—or at least of purification—of water had been carried out in several directions. Just prior to the war dependence had largely been placed on the use of filter-candles, but they were found to be unsuitable for active service conditions, and were replaced in every case by chlorination. The net result of war experience was the undoubted value for sterilisation purposes of chloride of lime in the form of bleaching powder. This substance, as is generally known, contains from 30 to 33 per cent. of available chlorine, which in turn liberates nascent oxygen in water, and this is effectively lethal to micro-organisms. Chloride of lime was used throughout the war as the means of dealing with all water-supply, either in bulk, as in the big "water-points," or regimentally in water-carts, pakhals, or containers of different shapes and sizes. As the war proceeded the need for the provision to advancing troops of properly treated water in large quantities led to the development of special Water-tank Companies. These units—first recommended in France by our own sanitary advisers—are capable of collecting, filtering under pressure through sand, sterilising by chlorine gas (by means of an ingenious regulator), and transporting large quantities of water wherever the motor-lorry (which was their basis) could move. In the same way barges for use along the waterways of the various theatres of war were developed. As an example, it may be mentioned that the ordinary barge of Northern France would deal with—and deliver—5000 gallons of pure, sterile, and tasteless water per hour; any suggestion of flavour of chlorine was removed by a "dechlorinating" process with sulphur dioxide gas.

These new water units proved of immense value, and are effective against mineral poisons as well as against bacterial or protozoal contamination. To meet the varying requirements of the different waters utilised in, *e.g.*, France or Egypt or Murmansk, different amounts of "bleach" were needed. The estimation of the required quantity would have been a matter of some difficulty but for the provision of a special test in the form of the "Horrock's Test Case," the action of which is based on the known fact that, generally speaking, 1 part per million of free chlorine suffices to ensure bacterial sterilisation in water, and that before this amount of free chlorine is available a certain varying amount will be used up indirectly in the oxidation of organic matter and the ordinary non-pathogenic or saprophytic organisms. Similarly, in view of the possibility of mineral poisons, medical officers were supplied with test cases to detect arsenic and the other commoner metallic poisons. Of the detail of the water organisation there is barely time to speak here. It is perhaps enough to say that, despite the variety of the theatres of war and the possible contaminations in these various areas, there was no outbreak of those water-borne diseases which have been so destructive to armies in the past. In this connection it may be of interest to add that the success of water chlorination in the field led to its adoption in certain major schemes at Boulogne and Rouen, where, for example, we were enabled to undertake chlorination of the municipal water-supplies, and so satisfactory was this that laboratory tests showed the tap-water of Boulogne, drawn at random some few weeks after the scheme was initiated, to be absolutely sterile. It is interesting to note that the American Forces adopted a similar scheme in a number of the larger towns in France occupied by their troops with equally good results. It is necessary to say how much of the excellence of the water arrangements was due to the high technical skill of the Royal Engineers in their very difficult task of providing the huge quantities required. In many cases this necessitated the actual boring of wells and the pumping forward to large "water-points," even in some cases to the trenches, by means of rapidly laid pipe-lines. During the offensive in the summer of 1918 the Third Army advanced through a waterless zone having a frontage of 12 miles and a depth of 20 miles; water was obtained by means of 6-in. bore-holes sunk by the Royal Engineers in the chalk, which yielded 9000 gallons per hour. Altogether, 500,000 gallons were obtained daily from the bore-holes and distributed to the troops by the Water-tank Companies. This method was continued until the enemy's water system was available.

I would now briefly touch on the question of *air and ventilation*. At an early date after the Crimea it was recognised that "spacing out" of men in barracks was essential, and the Army Regulations were framed to give every man a space of 600 cub. ft., or, assuming a 10 ft. high room, 60 sq. ft. of floor-space. This very excellent decision was in itself sufficient to reduce markedly the sick-rate and death-rate from tubercular and other respiratory diseases; and, in view of latter-day knowledge, was a remarkable piece of foresight. One need scarcely recall Pflüger's experiments on droplet infection, and how he showed the range of such infection from mouth to mouth to be somewhere within 1½ metres—in other words, that that range should represent the minimum proximity of men's heads in barracks or beds. The importance of that knowledge had not, perhaps, been fully realised, or, at any rate, had been submerged by reason of national necessity. Two instances have, however, recently shown that the principle involved—now known as "spacing-out"—cannot be disregarded. These were (1) the cerebro-spinal meningitis outbreak, starting in

1915, and (2) the influenza outbreak of 1918. In both these instances a populace, largely non-immune, was unavoidably—by military and national necessities—concentrated, with a resultant reduction in the spacing-out, and an opportunity arose for "mouth-to-mouth" or "droplet" infection. It is scarcely necessary to say that the pressure of hygienic advice was sufficient to represent the needs of the problem in each case. In the cerebro-spinal meningitis outbreak immediate spacing-out of the affected troops produced a rapid fall in the case and "carrier" incidence; in the same way, strong representations as to the need for drastic reductions in the number of troops carried in confined areas, such as ships, or of the methods of slinging hammocks in respect of the head positions, were latterly effective in reducing the unfortunately high incidence of influenza on its last appearance as a pandemic.

It may be of interest to note that the experience of the war had led to a reconsideration, and still further enlargement, of the cubic space allowed the troops, particularly overseas; and also of the correlated questions of pharyngeal and pulmonary disinfection. The importance of the former point—pharyngeal disinfection—was early recognised, and all transports were provided with means for dealing with the *personnel* aboard in special inhalation chambers. It is intended that these shall be a permanent feature of transports in the future, and it is of interest in this connection to note the recent encouraging reports from industrial works of the value of certain gases, inhaled in insensible but definite amounts, in inhibiting the incidence of influenza and allied respiratory disorders.

So much, then, for questions affecting all the troops. Now we come to the more special problems affecting particular groups of soldiery, and perhaps the most important is the *control of outbreaks of infectious disease*.

Epidemic disease, with the exception of the influenza pandemic, was noticeably absent, and the care taken to filter off "unfits" on the lines of communication went far to explain the remarkable freedom from disease of the men in the line. In respect of the excremental diseases, with their evil record of morbidity in past wars, and particularly of Enterica, the problem was approached in two ways: First, by the general inoculation of the troops so as to provide a relatively high immunity, and, secondly, by the careful disposal of all infected matter—in other words, by good conservancy methods. Inoculation during the early part of the war was carried out with typhoid vaccine, and a very large proportion of the troops was protected in this way. Later, in 1915, a triple vaccine was used—"T.A.B."—while troops proceeding East were provided also with cholera vaccine.

The sanitary sections were chiefly responsible for the constructional, advisory, and inspectorial duties involved in providing fly-proof field latrines of the deep-pit type, food larders, and safes for units otherwise unprovided, for the continued and varying problems connected with the reduction of the fly population, and for the supervision of large water schemes. The fly question, especially in Eastern theatres, is a vast and difficult one in view of the quantity of horse-litter inevitably associated with the Army, and frequently of the tactical or climatic impossibility of burning such fertile breeding matter. The Army was fortunate in being able to utilise expert advice on the problems raised from prominent entomologists, and in having officers and men who set themselves enthusiastically to carry out the methods adopted or tested.

But while the more serious diseases were largely defeated, it was found that there was a very considerable wastage in all theatres of war from insect-borne diseases of different types. In France a very great deal of the minor sickness of the troops was traceable to louse infestation, either as the cause of various septic skin conditions or from trench fever, which was early recognised as a new clinical entity, and has now been clearly proved to be a louse-borne disease. This question of the infestation of troops with lice is one of the most difficult problems of the sanitary officer, particularly in the case of troops crowded together or living under unnatural trench conditions. To this question the energies of a very considerable *personnel* were directed, and to it all the support of the military authorities was lent. The sufferings of our Allies the Serbs, and since then of a majority of the population of Eastern Europe, from another louse-borne infection, typhus fever, also emphasised the necessity for a vigorous campaign of disinfestation. The problem was met largely by the simultaneous provision of facilities for bathing at intervals not exceeding a week or ten days, and by the increase in facilities for disinfecting personal clothing and blankets at one and the same time.

At this point it appears suitable to mention the development in methods of disinfection by steam. In the early days the troops in the field were dependent on the few box-disinfectors available, while the rearward units were supplied with Thresh disinfectors. With the provision of divisional sanitary sections, portable Thresh machines were also supplied to each division. It was soon apparent, however, that for the regular treatment of clothing required by the anti-louse campaign this was not sufficient. The ultimate development which resulted was the Foden-Thresh apparatus, comprising two large Thresh disinfecting chambers mounted on, and operated under slight pressure by, a Foden steam lorry. In this way the apparatus could be rapidly moved to any area in which it was required, at once commence operations by turning the steam into the chambers, and then be driven to a fresh centre for operations.

The disinfestation centres were of immense value, but were often inadequate to eradicate the louse plague entirely owing to the escape of certain individuals or articles. To meet the needs of men in such circumstances, general issues were made of certain repellent substances of proved value, but more reliance was placed on the regular treatment of clothing and blankets; and the experience gained in this connection will be of lasting value, for there has developed, as one profoundly valuable result, the use of hot air as a practical method of disinfestation—a method even simpler, cheaper, and more rapid than steam, and one destined, it is hoped and anticipated, to hold a permanent place in the larger schemes of control of insect infections of the future. It is of interest to note that flour-millers in Canada are now utilising this method for the destruction of moths in preference to the older and more dangerous "H.C.N." method. The latest "Orr hot-air huts" are models of efficient disinfectors. The subject, however, remains one for further study and co-operative methods of control. The problem to be met during the demobilisation of 20,000 men daily from France (and of smaller numbers from elsewhere), was no easy one, but of the utmost importance in order to avoid the dissemination of infective disease among the civil community. Careful personal inspection was, of course, required in every case, combined with bathing, disinfection, and the issue of fresh clothing, and this colossal undertaking was carried out to complete satisfaction at a series of stations—at base ports in France each capable of dealing with no fewer than

3000 men per day prior to their embarkation. The absence in the community at home of any noticeable incidence of trench, relapsing, or typhus fevers goes to show the justification of the claim to success of the sanitary officers and *personnel* concerned in these works.

There were other insect-borne infections to be guarded against in different parts of the world where the military situation required our troops to serve. In some of these cases hygienic control was necessarily subservient to military urgency, and outbreaks of sickness occurred, the more readily so, perhaps, in the light of the unprepared soil which our young troops offered on first entry into tropical and sub-tropical zones. There is not time to detail the various minor hygienic campaigns, but the vast amount of anti-malaria work carried on in the various overseas war zones justifies notice. Being carried out, often with most complete success, from the point of view of mosquito elimination, there were at the same time areas where enemy action almost entirely forbade active measures of drainage, canalisation, or oiling. Even in these circumstances, however, it was not uncommon for certain of our officers, accompanied by a guard of two or three men, to push out into No Man's Land to oil certain stagnant waters known to be mosquito-breeding places. As to the extent of work carried out in draining, ditching, filling-in, etc., exact figures are scarcely procurable, but in the aggregate the efforts made must rank among the major schemes of the world, and be of incalculable value both by the improvement made and as an example to the inhabitants of the various areas concerned—Egypt and Palestine, Macedonia, Lower Mesopotamia, etc. In addition, however, to these offensive measures, defensive action against malaria was generally and thoroughly carried out by means of the provision of quinine, of netting of different forms, of special clothing, gloves, head-nets, etc., and of repellent substances, as also by the treatment of infected natives and various schemes for the isolation and removal of infected men who would otherwise act as foci for fresh cases.

From another aspect altogether the sanitary sections rendered valuable service; I refer to the economies effected. These economies were both direct and indirect. In the latter category may be placed the saving effected by the adoption of destruction of excremental matter by unit incineration which otherwise had to be disposed of with considerable expense by contract removal. Even of greater interest, however, was the direct saving resulting from the adoption of improved sanitary technique. In this category may be mentioned, first of all, the saving of fat. One of the most difficult waste-matters to get rid of in a cleanly way is greasy water—wash-up water, kitchen swill, etc. In seeking for better methods of disposal of this sullage the special cold-water grease-trap was devised, and soon pointed the way to an obvious economy. By the careful collection of all such wash-up fat, and of the scrap-fat and bone-fat rendered in cookhouses, a bulk of crude fat was obtainable which proved of immense use in aiding the national resources. A campaign of fat-saving was first initiated by the sanitary sections, and later developed and organised by the Quartermaster-General's Department. It was so successful that many of the war zones were able to make all their own soap locally, and, furthermore, to send home many tons of fat for making glycerine, then so necessary for the manufacture of munitions. As an instance, the saving of an average battalion was some 60 lb. of fat per day at a time when fat fetched at least 40*l.* per ton.

Another very useful economy was the collection of the solder from the sealing of the myriad tins used as food-containers. Nothing could be more striking than the picture presented by an up-to-date unit destructor consuming in cleanly fashion all the waste matter from a large camp, and at the same time melting out from improvised receptacles streams of solder, which dripped into cold-water receivers, while the heat of the furnace was utilised to heat large tanks of water, of value both for ablution and for the various washing-up processes so constantly required.

During the war many scientific investigations were carried out, both at home and in the actual theatres of war, for the elucidation of disease and the determining of the best modes of prevention. In some cases this necessitated the investigation of certain diseases which were either unknown in former campaigns or had been little studied in the past. Very valuable aid was given by the labours of the Trench-fever Committees at home and in France, and also by the War Nephritis Committee and Medical Research Committee in France. It having been clearly established that trench fever is conveyed by the louse, and diagnosis having been made possible, a great impetus was given to general measures of personal hygiene in the field, and also to improvement in methods of bathing and disinfestation. Trench fever was made notifiable in consequence, and a very great improvement resulted from the increased attention to precautionary measures. At the termination of the war the diseases had greatly declined, and no infection was conveyed to England on demobilisation.

By the labours, in short, of the united profession, all doing that work which was required of them and which local authority considered most immediately necessary, the troops were served as few armies have ever before been served.

In France, for instance, in 1918, out of a mean strength of 1,250,000 men of all races, the typhoid admission rate amounted to only 0·2 per thousand per annum, whereas in the case of the war in South Africa the admission rate reached the high figure of 130 per thousand.

In the case of dysentery the total number of deaths from this disease in France during the whole war was fewer than 200. These figures in themselves are a sufficient and lasting tribute to that branch of the Army to which so many of our profession have belonged, and from which we hope they have taken something in exchange for the much they brought to it.

An inevitable result of the war has been the recognition by everyone engaged of the value of "preventive medicine." This has led, on one hand, to the definite recognition of the Sanitary Service in the Army as an organised department, and has aroused, on the other, an increased interest among thoughtful members of the civil community into their own state—an interest which provoked the demand for an organised national effort, and ultimately led to the formation of the Ministry of Health.

In summing up my views, I would say that, in my opinion, the future prosperity and success of our nation depend to an incalculable extent on the improvement of the physical and mental standard of all members of the community; it must not merely be—as I am afraid it has been to a considerable extent in the past—a case of the "survival of the fittest," but rather a perfection of every method by which mortality may be decreased, by which the production of "unfits" may be diminished, and by which the

standard of fitness as regards man, woman, and child may be raised.

To attain this result we must all work together. In the words of Pope:

> By mutual confidence and mutual aid
> Great deeds are done and great discoveries made.

University and Educational Intelligence.

CAMBRIDGE.—Dr. Adrian has been appointed University lecturer in physiology, and Mr. F. A. Potts, of Trinity Hall, has been appointed University lecturer in zoology.

The Harkness scholarship has been awarded to E. W. Ravenshear, of Clare, and the Frank Smart prizes in botany and zoology to R. E. Holthum, of St. John's, and G. T. Henderson, of Gonville and Caius, respectively.

A second *ad interim* grant of 30,000*l.* has been made by the Government to the University pending the result of the inquiries of the Royal Commission.

An important report has been made by the Local Examinations and Lectures Syndicate, urging an extension of the provision of both money and men for extra-mural teaching.

The Board of Agricultural Studies has received a donation of 1000*l.*, collected by Sir Arthur Shipley, for the provision of lectures on tropical agriculture for five years. Dr. C. A. Barber, of Christ's, late of the Imperial Department of Agriculture, West Indies, and of the Indian Agricultural Service, has been appointed lecturer in tropical agriculture for five years.

Miss B. A. Clough has been appointed principal of Newnham College in succession to Miss K. Stephen.

EDINBURGH.—The University Court has appointed Mr. E. P. Stebbing, lecturer in forestry, to the recently instituted chair of forestry. The Court has also appointed Mr. John Petrie Dunn, a former Bucher scholar of the University, who at the outbreak of the war was Vice-Principal of the Kiel Conservatoire, as a part-time lecturer in the department of music.

The late Dr. J. G. Bartholomew has bequeathed to the University the sum of 500*l.*, to be applied towards the foundation of a chair in geography.

LEEDS.—Dr. W. E. S. Turner has been appointed professor of glass technology, Mr. J. Husband professor of civil engineering, and Dr. Mellanby professor of pharmacology. Mr. R. E. Pleasance has been appointed demonstrator in pathology.

LIVERPOOL.—Dr. W. J. Dakin, professor of biology in the University of Western Australia, has been appointed to the Derby chair of zoology in succession to the late Prof. Leonard Doncaster. Dr. I. M. Heilbron, professor of organic chemistry at the Royal Technical College, Glasgow, has been appointed to the chair of organic chemistry.

OXFORD.—Dr. Benjamin Moore, of the Research Staff, Department of Applied Physiology, Medical Research Committee, has been appointed to the new chair of biochemistry. The Halley lecture is to be delivered by Prof. R. A. Sampson.

PROF. J. STRONG, of the University of Leeds, has been elected president of the Association of University Teachers for the ensuing year.

DR. W. N. HAWORTH has been appointed to the chair of organic chemistry at Armstrong College, Newcastle-upon-Tyne, in succession to Prof. S. Smiles.

DR. V. J. HARDING, associate-professor of biological and physiological chemistry at McGill University, has been appointed professor of pathological chemistry in the University of Toronto.

MR. J. W. SCOTT, lecturer in moral philosophy in the University of Glasgow, has been appointed professor of logic and philosophy in the University College of South Wales and Monmouthshire.

A SUMMER school of librarianship is to be held at Bristol from August 30 to September 11, under the auspices of the University of London School of Librarianship. Some twenty-five papers have been promised for delivery.

THE Report of the Librarian of Congress for the year ending June 30, 1919, shows that the work of the principal library in the United States was carried on with success during the war in spite of great difficulties. Members of the staff died in the war and others have not returned, or have resigned on finding more lucrative work elsewhere. The work has also been hindered by a general rise in prices. The number of printed books now in the library is about 2,700,000. The Library of Congress prints a card catalogue of its books, which is justly valued for its accuracy. By June 30, 1918, the number of different titles in this card-index was 789,000. The average stock of each card was 75 copies, making the total number of cards in stock 60,000,000. The number of subscribers to these cards is 2693, and the sale of cards for the year produced 73,000 dollars. A large number of Chinese books has recently been purchased. The Chinese section is a unique feature of the library, and now contains no fewer than 887 Chinese official geographical gazetteers. These gazetteers are of great value in the study of the industry, art, agriculture, and geography of China. The report invites executors or others who may possess manuscript papers relating to persons of national importance in politics, science, literature, or art to submit these papers for examination. The librarian undertakes to return papers of a strictly personal or family character, and to preserve any valuable material that might otherwise be lost or destroyed.

Societies and Academies.

LONDON.

Royal Society, June 10.—Sir J. J. Thomson, president, in the chair.—A. V. **Hill** and W. **Hartree**: The thermo-elastic properties of muscle. The employment of a thermopile in a carefully closed-in chamber, immersed in well-stirred water inside a double-walled vacuum flask, together with photographic registering of the galvanometer response, has made it possible to record the thermal consequences of stretching a muscle (or a piece of indiarubber) or of releasing a muscle already stretched. When a muscle, alive or dead, is *stretched*, heat is liberated in relatively large amount at first, but at a rapidly diminishing rate. When a stretched muscle is *released*, there is at first a rapid absorption of heat, followed by a more prolonged evolution of heat. In a complete cycle of lengthening and shortening the net result is a production of heat, which is greater the longer the interval between the two processes. These thermo-elastic effects are large enough to afford a notable complication in the measurement of the heat-production of a live muscle excited to contract. Their explanation is as follows:—(*a*) The muscle, like a fiddle-string, shortens on being warmed; conversely, according to the second law, it will warm on being

stretched and cool on being released. This explains the initial effects. (*b*) The muscle, like other colloidal jellies, takes some time to reach an equilibrium length on being stressed; consequently, on stretching it *more* work is done, and on releasing it *less* work is obtained than is accounted for by the elastic potential energy existing in it when it has reached its full equilibrium length. The balance in either case appears as an irreversible production of heat. This accounts for the secondary effects. The phenomena appear to be of physical as well as of physiological interest.—Sir James **Dobbie** and J. J. **Fox**: The absorption of light by elements in the state of vapour: Selenium and tellurium. In a previous communication (Proc. A, 1919, vol. xcv., p. 484) it was shown that the absorption of light by sulphur vapour reaches a maximum at a temperature of about 650° C., and that at this temperature the vapour density corresponds with the average molecular weight S_3. Selenium and tellurium behave much in the same way as sulphur, the absorption increasing up to a certain temperature, above which it again diminishes. In the case of selenium the maximum absorption occurs between 650° C. and 700° C., and vapour-density determinations show that the average molecular weight at this point corresponds to Se_3. With tellurium the maximum absorption is found to occur about 1200° C. The vapour of this element consists of diatomic molecules at 1800° C., but nothing is known of its constitution at lower temperatures. Its general similarity, however, to sulphur and selenium as regards absorption of light renders it highly probable that at 1200° C., and below this temperature, the vapour is much more complex than at 1800° C. The absorption spectra of selenium and tellurium are marked by the presence of large numbers of sharp narrow bands, and that of tellurium shows a wide absorption band of which the centre is approximately at λ3800.—Sir James **Dobbie** and J. J. **Fox**: The absorption of light by elements in the state of vapour: Mercury, cadmium, zinc, phosphorus, arsenic, and antimony. These elements, unlike those of the sulphur group, do not show channelled absorption spectra when the Nernst filament is used as the source of light. Mercury, cadmium, and zinc, which are monatomic, transmit practically the whole of the light at all temperatures. Cadmium, however, shows a few narrow absorption bands, of which one at λ3261 is the most striking. In the cases of the tetratomic elements, phosphorus, arsenic, and antimony, general absorption occurs and increases regularly with rise of temperature up to 1400° C. There is no indication of a maximum followed by a diminution of absorption. The peculiar absorption phenomena of the elements of the sulphur group are in all probability due to the breaking-down of complex into simpler molecules, *e.g.* S_8 into S_2, with the formation of molecules of intermediate complexity. With monatomic molecules no such dissociation can occur. With the tetratomic elements there is undoubted dissociation; but the changes are much less complicated than in the case of sulphur, the tetratomic molecules simply splitting up into diatomic molecules. It is, however, to be noted that the highest temperature at which silica tubes can be used is 1400° C. It is possible that at still higher temperatures further dissociation of the tetratomic elements would result, accompanied by absorption phenomena similar to those observed in the case of sulphur.—A. E. H. **Tutton**: Monoclinic double selenates of the copper group. This memoir deals with the four double selenates of the series $R_2M(SeO_4)_2,6H_2O$, in which M is copper and R is potassium, rubidium, cæsium, and ammonium. A complete crystallographic and physical investigation has been carried out, similar to the work previously published concerning the magnesium, zinc, iron, nickel, and cobalt groups, and to that on the analogous double sulphates. The results confirm the conclusions derived from all the groups previously studied, and in a peculiarly valuable manner; for the copper-containing group affords crystals with morphological angles and elements and physical constants which differ appreciably in their absolute values from those afforded by the other groups, in this respect resembling the double sulphates containing copper. Yet the relationships between the values for the four salts are precisely the same, leading thus to exactly the same general conclusions as in the cases of those other groups. Every group exhibits its own idiosyncrasies, and the copper groups do so in a specially notable manner. Yet the same progression, according to the atomic weight and atomic number of the alkali metal present, is exhibited in the case of every property, whether morphological, such as the crystal angles and the topic axial ratios, or physical, such as the double refraction and the molecular refraction; also the ammonium salt proves to be practically isostructural with the rubidium salt. The most recent work on the structure of the atom and the further elaboration of Moseley's law connecting the atomic number with the atomic structure and complexity has only strengthened the conclusion that the author's results are a natural consequence of the operation of Moseley's law: the progression in the crystal properties following the progression in the complexity of the alkali-metallic atoms, which exert so dominating an influence in determining the structure and properties of these crystals.—H. G. **Cannon**: Production and transmission of an environmental effect in *Simocephalus vetulus*. The experiments were undertaken in order to repeat, if possible, Agar's work on the production and transmission of an abnormality in *Simocephalus vetulus*. The magnitude of the abnormality, which consisted in a change in the curvature of the valves of the carapace, could be measured by the length/width ratio L/W. The results indicate that the abnormality can be produced by feeding a culture containing practically no other protozoon than Chlamydomonas. The L/W ratio was found to be too variable to allow of its measurement with sufficient accuracy on which to base considerations as to the existence or non-existence of a "reaction" to the abnormality of such a magnitude as that indicated by Agar. The experiments showed that no antibody was produced to eliminate the cause of the abnormality.—E. C. **Grey**: The enzymes of *B. coli communis*, which are concerned in the decomposition of glucose and mannitol. Part iv.: The fermentation of glucose in the presence of formic acid. By carrying out the fermentation of glucose by bacteria in the presence of calcium formate the author has been able to upset the normal balance which exists between certain of the products, and thus to show that they are in reality formed by separate enzyme actions. Hitherto an approximately constant relationship has been found between the formic acid and carbon dioxide on one hand, and the alcohol and acetic acid on the other. This relationship is shown to be rather accidental than essential. It results probably from the fact that the hydrogen which arises from the decomposition of formic acid co-operates in the formation of alcohol, and thus the two reactions of alcohol formation and carbon dioxide formation tend to keep pace with one another. The addition of more formic acid at the outset of the fermentation tends, however, to prevent the production of formic acid from glucose, and to destroy the ratio which normally exists between this formic acid and the alcohol and acetic acid, thus proving that these products arise by at least two separate enzyme actions. Taken in conjunction with the author's previous finding, that lactic acid is formed

from glucose by *Bacterium coli* by a mechanism which is independent of that which gives rise to the other products, it is clear there that glucose may break down under the influence of these bacterial enzymes in three independent ways, giving rise to the following three groups of products :—(1) Formic acid, carbon dioxide, and hydrogen. (2) Alcohol, acetic acid, and succinic acid. (3) Lactic acid. These groups apparently represent three separate lines of cleavage of the glucose molecule under the influence of the enzymes of the bacterium in question. The author is of opinion that this manner of cleavage is fundamental. The experiments also show that alcohol is produced, in part at least, by reduction, and prove for the first time that such reduction does actually occur by the action of hydrogen liberated from the glucose, as well as that, in certain circumstances, the hydrogen derived from the added calcium formate exerts a reducing action and increases the yield of alcohol.—L. T. **Hogben**: Studies on synapsis. ii.: Parallel conjugation and the prophase complex in Periplaneta, with special reference to the premeiotic telophase. Synapsis in the Orthoptera has been the subject of considerable controversy. The earliest events of synapsis in the ovaries of the cockroach are traceable with much greater facility than in the testes. They involve in either case the parallel conjugation in pairs of the full diploid number of leptotene loops. Morse's account of the origin of the heterotype rings by separation of the diplotene threads along the line of cleavage is confirmed and amplified by a sequential analysis of the metaphase complex. It is seen that two chromosomes at this stage (*d* and α^1) retain the looped condition of the post-synaptic bouquet until the others have divided —a fact which led earlier workers to interpret the genesis of the heterotype annular chromosomes according to the telosynaptic hypothesis. The accessories are not distinguishable in oogenesis from the autosomes. The vacuolation of the plasmosome during yolk-formation in the oocyte is described in detail, and a re-examination of material for a previous paper indicates that the so-called "chromatin" granules described by so many writers, as emitted during yolk-formation in the insect egg, are in reality products of the plasmosome. There is no evidence that in Periplaneta the plasmosome is related in any way to the chromatin organisation of the nucleus.

PARIS.

Academy of Sciences, June 7. M. Georges Lemoine in the chair.—C. **Moureu** and G. **Mignonac**: Acylketimines. Benzonitrile, magnesium, and an alkyl bromide give the product $C_6H_5.CR:N.MgBr$, and with an acid chloride acylketimines are obtained of the type $C_6H_5.CR=N.CO.CH_3$. Details of the general method of preparation and the melting points of six acylketimines are given.—G. **Bonnier**: The changes in plant forms obtained experimentally. Full descriptions of the changes brought about in seventeen species of plants by change of altitude. The plants were grown in similar soil in the plains and in the mountains, and the observations extended for a period of from six to thirty-four years.—A. **Rateau**: The theory of aerial and marine propulsive helices and of aeroplanes in rectilinear flight.—M. Kamerlingh Onnes was elected a correspondant for the section of physics in succession to the late Sir William Crookes.—G. **Julia**: Functions of two complex variables and limiting functions of analytical functions, uniform or multiform, of one variable.—R. **Thiry**: The conformal representation of doubly connected with rectilinear contours.—H. **Villat**: The conformal representation of doubly connected areas.—B. **Gambier**: The surfaces of translation of Sophus Lie.—L. **Dunoyer**: Magnetic induction in the soft iron compass correctors under the influence of the needles. Modifications of a formula given in an earlier communication required by the discovery of an error in sign.—L. **Barbillion** and M. **Dugit**: The rectilinear scale with equidistant divisions applied to the measurement and division of angles and measuring apparatus of constant sensibility. —Mlle. Paule **Collet**: The reproduction of speech by galena and sustained waves.—L. and E. **Bloch**: Production of the band spectra of nitrogen by electrons of low velocity. Earlier experiments of this nature have been made by the electrical method: the examination of the angular points in the curve of the current produced by the electrons. In the work here described a quartz prism spectrograph was employed and the nitrogen bands were directly observed. It was found to be possible to get the nitrogen radiation at a critical potential of about 10 volts. Hence band spectra, like line spectra, can be excited by electron shock with a voltage clearly lower than the ionisation potential (18 volts).—C. **Benedicks**: The electrothermic effect in a homogeneous conductor of constant section.—C. **Raveau**: Variance and the means of presuming the value of it without the aid of a formula.—P. **Bary**: The viscosity of colloidal solutions. A study of the swelling of colloids in suspension based on Einstein's formula for the viscosity of liquids holding solid matter in suspension.—M. **Delépine** and L. **Ville**: The chloride of bromine: its combination with ethylene. Forty years ago Maxwell, Simpson, and James showed that ethylene chlorobromide, $ClCH_2.CH_2Br$, was the product of the reaction of ethylene on "chloride of bromine" in a solution of hydrochloric acid. Recent physico-chemical work, on the other hand, goes to prove that chloride of bromine does not exist, and that the substance passing under that name is merely a mechanical mixture of bromine and chlorine. The authors have examined the action of ethylene on dry "chloride of bromine," and find that the compound C_2H_4ClBr is undoubtedly the main product. From this work the conclusion is drawn that, in some cases at least, physico-chemical data cannot be relied upon to prove the non-existence of a chemical compound.—H. **Gault** and R. **Weick**: A case of isomerism in the series of the aromatic α-ketonic acids. The existence of two isomeric phenylpyruvic ethers is proved, and the conditions under which one can be converted into the other determined. —J. **Bougault** and J. **Perrier**: New researches relating to the action of hydrocyanic acid on glucose. The fact that in presence of an excess of potassium cyanide the glucoses form cyanohydrins quantitatively suggested that this reaction might be utilised for the exact estimation of glucose, and the conditions for accurate estimations are given. When the glucose is in excess the cyanide is rapidly converted into the non-poisonous cyanohydrin, and an experiment is cited in which 0·25 gram of potassium cyanide mixed with 6 grams of honey and 6 c.c. of water were given to a guinea-pig after the mixture had been allowed to stand fourteen hours to complete the reaction. The animal showed no signs of poisoning. The consequences of these results from a toxicological point of view are discussed.—G. **Guilbert**: The application of cirrus clouds to the prediction of the weather.—H. **Ricome**: The phenomenon of torsion comparable to the rolling-up of tendrils produced experimentally.—F. **Moreau**: The different aspects of lichen symbiosis in *Ricasolia herbacea* and *R. amplissima*.—J. **Stoklasa**: The action of hydrocyanic acid on the organism of plants. The spores of *B. subtilis* and *B. mesentericus vulgatus* resist the toxic action of air containing 3 per cent. of hydrocyanic acid by volume, but exposure of twenty-four hours to 3·5 per cent. by volume arrests further development. *Mucor mucedo*, *M. stolonifer*, and *Penicillium glaucum* behave similarly, and *Aspergillus*

glaucus requires a strength of 4 per cent. for destruction. Micro-organisms offer very great resistance to the action of hydrocyanic acid. The conditions under which seeds can be exposed to hydrocyanic acid vapour without damage have been worked out, and experiments cited showing how this method can be used for the practical disinfection of seeds affected with parasites.—A. **Krempf**: The blastodermic origin of the enteroids and of the enteroido-pharyngeal complex in the Anthozoa.—W. **Kopaczewski**, A. H. **Roffo**, and Mme. H. L. **Roffo**: Anæsthesia and anaphylaxy. The authors have found that anæsthetics and analgesics possess the well-marked property of diminishing the surface tension of serum. On the other hand, it has been proved that all the substances used for the prevention of anaphylactic phenomena, such as lecithin, the alkalis, and soaps, also have the property of lowering the surface tension. Experiments are given on the suppression of anaphylactic shock by anæsthetics. The results obtained confirm the view that it is not the nervous system which is mainly affected by the anaphylactic shock, but a reaction of colloidal flocculation leading to asphyxia from the obstruction of the capillary networks.—A. G. **Pellissier**: Modifications and lesions of the pulmonary epithelial cells due to suffocating gases.—G. **Marinescu**: The modifications of the oxydases during the evolution of the neurone.—R. **Cambier**: The purification of sewage effluents by activated sludge.—H. **Vallée** and L. **Bazy**: Bacteriotherapy by microbial extracts.—A. **Mayer**, H. **Magne**, and L. **Plantefol**: The mechanism of death in the case of acute pulmonary œdema caused by the inspiration of noxious vapours or gases.

Books Received.

Forest Products. By Prof. N. C. Brown. Pp. xix+471. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 21*s*. net.

Practical Geometry, pp. xv+256; Theoretical Geometry, pp. xiv+104. By C. Godfrey and A. W. Siddons. (London: Cambridge University Press.) Complete, 7*s*. net.

A Primer of Trigonometry for Engineers. By W. G. Dunkley. Pp. viii+171 (with Answers). (London: Sir Isaac Pitman and Sons, Ltd.) 5*s*. net.

Pyrometry. By C. R. Darling. Second edition. Pp. xii+224. (London: E. and F. N. Spon, Ltd.) 10*s*. 6*d*. net.

The Chemist's Year Book, 1920. Edited by F. W. Atack, assisted by L. Whinyates. 2 vols. Vol. i., pp. vi+422; vol. ii., pp. vii-viii+423-1136. (London and Manchester: Sherratt and Hughes.)

Phosphore, Arsenic, Antimoine. By Dr. A. Boutaric and A. Raynaud. Pp. iii+417. (Paris: O. Doin.) 9.50 francs.

Traité de la Lumière. By C. Huyghens. Pp. x+155. (Paris: Gauthier-Villars et Cie.) 3.60 francs.

Food Inspection and Analysis. By A. E. Leach. Fourth edition. Pp. xix+1090+xli plates. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 45*s*. net.

Vertebrate Zoology. By Prof. H. H. Newman. Pp. xiii+432. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 16*s*. net.

A Second Book of School Celebrations. By Dr. F. H. Hayward. Pp. 133. (London: P. S. King and Sons, Ltd.) 5*s*. net.

Stories for the Nature Hour. Compiled by A. M. Skinner and E. L. Skinner. Pp. 253. (London: G. G. Harrap and Co., Ltd.) 5*s*. net.

Surveying. By W. N. Thomas. Pp. viii+536 (with Answers). (London: E. Arnold.) 31*s*. 6*d*. net.

Diary of Societies.

THURSDAY, JUNE 24.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), Annual Summer Congress, at 2.30.—Papers on Cancer of the Throat, with Discussion.

ROYAL SOCIETY, at 4.30.—Sir Ray Lankester: Some Rostro-carinate Flint Implements and Allied Forms.—Lord Rayleigh: A Re-examination of the Light scattered by Gases in respect of Polarisation. I. Experiments on the Common Gases.—A. Mallock: Note on the Influence of Temperature on the Rigidity of Metals.—Drs. E. F. Armstrong and T. P. Hilditch: A Study of Catalytic Actions at Solid Surfaces. V. The Rate of Change conditioned by a Nickel Catalyst and its Bearing on the Law of Mass Action.—Dr. H. Jeffreys: Tidal Friction in Shallow Seas.—Other Papers.

LINNEAN SOCIETY OF LONDON, at 5.—Dr. C. J. F. Skottsberg: Recent Researches on the Antarctic Flora.—Dr. R. J. Tillyard: The Cawthron Institute, New Zealand, and its Biological Function.

OIL AND COLOUR CHEMISTS' ASSOCIATION (at Food Reform Club, 1, Furnival Street), at 7.30.—A. E. Bawtree: (1) A Hydrometer for Accurate Determinations of Pastes and Viscous Materials; (2) A Viscometer which Combines Increased Efficiency with the Power of Measuring "Stickiness" Independently of Viscosity.

SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, JUNE 25.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), Annual Summer Congress, at 10 a.m.—Papers on Cancer of the Throat, with Discussion.

PHYSICAL SOCIETY OF LONDON, at 5.—Dr. J. H. Vincent: The Origin of the Elements.—W. H. Wilson and Miss T. D. Epps: The Construction of Thermo-couples by Electro-deposition.—J. Guild: The Use of Vacuum Arcs for Interferometry.—S. Butterworth: The Maintenance of a Vibrating System by Means of a Triode Valve.

WEST LONDON MEDICO-CHIRURGICAL SOCIETY (at Kensington Town Hall), at 8.15.—Prof. C. S. Sherrington: Posture (Cavendish Lecture).

TUESDAY, JUNE 29.

ROYAL HORTICULTURAL SOCIETY, at 3.—H. R. Darlington: Garden Roses.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 3-7.—Sir C. Hercules Read, T. Allworthy, V. B. Crowther-Benyon, S. Fenton, G. W. Willis, and others: Exhibition of Bronze Age Implements.

WEDNESDAY JUNE 30.

ROYAL SOCIETY OF ARTS, at 4.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Mechanical Engineers), at 6.—Sir Philip Dawson: Electric Railway Contact Systems.

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